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HUMAN FACTORS IN INDUSTRY

THERE has been much discussion in recent months of the problem of incentives as a means of encouraging increased effort and productivity in industry. Apart from economic and related aspects, the matter is of considerable interest to psychologists, social scientists and many other scientific workers, and it raises many issues which come into the field of scientific management.

When, in 1945, the Percy Committee issued its report on higher technological education in Britain, a major criticism was the inferior quality of the management literature of the country, and particularly the absence of the intellectual content of a sound mental discipline. It is early to look for much improvement in this respect; but one recent book, by Mr. R. P. Lynton, "Incentives and Management in British Industry"*, goes so far to meet this criticism as to indicate that the British Institute of Management is already making its influence felt in this respect. Mr. Lynton acknowledges help received from colleagues of the Field Research Group of that Institute, and whatever may be the indirect influence of the Institute on his thought, he has written a book that is far ahead of much American literature in this field, and which makes a really useful and challenging contribution to the subject.

Mr. Lynton, eschewing the irritating jargon which so often mars books written on management, puts the question of incentives in a broad and true perspective. He is sharply critical of both management and trade union policy, and though he writes with sympathy and insight and a keen appreciation of the contribution of Prof. Elton Mayo and many others, he puts his finger very accurately on the weak spots in our present policies, and the way in which the resistance to change, on both sides, and the lack of vision of the Government are causing such dangerous waste of human qualities in industry. Many of his observations, particularly those on the mistaken belief that the feeling of insecurity in work stimulates the competitive spirit, and on the indirect effects of the fear of unemployment on output or as an incentive require careful consideration. As he also points out, management must learn to discriminate effectively against the inefficient. Other matters raised are the declining extent to which workers can influence their wages, the influence and limitations of welfare arrangements, the question of training and the importance of managements finding out what work interests their workers.

A dominant impression left on the mind of the reader is that the task of exposition should be undertaken by British writers. Comparison with the volume edited by Mr. S. D. Hoslett under the title "Human Factors in Management", and published in Great Britain last year†, sufficiently illustrates this point. In that volume Mr. Hoslett has assembled contri-

* Incentives and Management in British Industry. By R. P. Lynton. Pp. viii+212. (London: Routledge and Kegan Paul, Ltd., 1949.) 15s. net.

† Human Factors in Management. Edited by Schuyler Dean Hoslett. Pp. x+316. (London: Macdonald and Evans, 1948.) 18s. net.

butions from such talented and well-known writers and expositors as Ordway Teed, Chester J. Barnard, F. J. Roethlisberger, W. J. Dickson and D. McGregor; and although the papers range over such topics as the nature of leadership, the researches at the Western Electric Co., foremen and their training, industry and the community and personnel work, the book does not lack unity. Indeed, it could equally well have been issued under Mr. Lynton's title, "Incentives and Management", but with the added proviso that it is confined to American industry.

The failure to interpret American experience in British terms, however, robs the book of much of its value in relation to the present discussions going on in Great Britain between the Government, managements and employees. In some ways the book may even do harm rather than good, since it is unlikely to hold, if it can gain, the interest of those who most need to be stimulated to fresh thought and effort in the field of industrial relations. This is unfortunate, for the literature of the subject is not so extensive that one can afford to pass over any serious contribution.

The paper on "Anthropological Engineering" well illustrates the weaknesses of the book. Even if anthropologists do not regard as too narrow the definition of their science as one which is concerned with the study of human relations, the use of the term 'engineering' in this context is not a happy one. Such terms as 'anthropological' or even 'human engineering' indicate an approach which cannot help, and indeed will probably hinder, the development of an atmosphere in which real progress is possible in the establishment of better relations between management and operatives, and in the promotion of policies in which incentives can really be effective. For this reason, the study of human relations and the establishment of anything approaching a science in this field will certainly not be forwarded by the use of such terms.

Lord McGowan's forthright speech in Birmingham on November 10, at the first of a series of 'free enterprise' meetings organised by the National Union of Manufacturers, frankly recognized that over-full employment has led to the breakdown of incentives to hard work, and that taxation had also tended to diminish effort. He showed that he is fully aware of the many ways in which this lack of effort manifests itself, and that he recognizes, too, the need for a closer understanding between the employers, the trades unions and the workers. Both tact, and a human understanding of the hopes and aspirations of employees, must be shown by employers in their relations with their workers.

Lord McGowan, however, is convinced that there is need for a wage policy, and that we require not a wage structure guaranteeing a certain standard of living but rather a wage policy of incentives and sanctions that will encourage the industrious and penalize the lazy. He advocates the increasing use in every industry where possible of work measurement and piece-rates as a method of wage payment, and he emphasized that the true solution to our difficulties is not so much to increase productivity but rather to obtain greater production from existing hours of work by greater effort. Extension of the working week by paying for the extra hours at overtime-rates is unlikely to provide a satisfactory answer. Lord McGowan also believes that substantial transfers of labour between industries and occupations are imperative, although the Government has rightly refrained from using to any extent its powers for compulsory direction of labour. We have no longer reserves or a pool of labour, and the readjustment of our industrial pattern to changing world conditions involves drawing labour from some industries if others are to expand; in other words, a certain amount of re-distribution of the labour force seems essential.

Mr. Lynton's book alone will show how much hard thinking and resolute but sympathetic action will be required to give effect to such a policy or programme as that indicated by Lord McGowan. Nor must the thought and effort required come from one side only. "Control is no substitute for incentives", Sir John Anderson remarked in the House of Commons on October 27, and the Government as well as industry has its part to play in establishing conditions in which incentives can be effective. Lord McGowan's speech is evidence that, in any event, some industrialists are aware of what is required, and the endorsement by the General Council of the Trades Union Congress of the recent report of its Economic Committee indicates that the trades unions, in theory at least, admit the need for relating earnings to output. The report gives official blessing to systems of payment by results and proposes special incentive schemes to help the lower-paid workers. There is, however, no hint in the report of how the abandonment of mobility in wages is to be reconciled with the need to increase the mobility of labour, although the value of incentives as a means of securing greater output or attracting workers to export industries may be underestimated. It remains to be seen how far the unions are prepared to accept the advice of their leaders; but meanwhile, readers of Mr. Lynton's book will be in no doubt about the urgent need for a widespread re-orientation of attitudes in industry on the part of employers and managements if the willing co-operation upon which the effectiveness of incentives so largely depends is to be secured. To that end the Government has its own contribution to make, and the fact that the decisive factors are so largely psychological should not be allowed to hinder the clear and fundamental thinking on ways and means which will be demanded of both sides, but particularly of management.

That is true particularly of joint consultations, where, in the first instance, almost everything depends on the approach made by management. But an effective economic policy is required to give the indispensable stimulus and incentive to greater efficiency and higher output, and to the more economic marshalling of man-power. That is primarily a responsibility of government, as is a lead in a conscious and calculated campaign to root out restrictive practices of all kinds.

Already it appears that the work of the Anglo-American Committee on Productivity may have a

profound influence on industrial productivity, and visits of teams like those from the steel founding industry may make a most important and even revolutionary contribution if fully utilized and handled with imagination. Neither side of industry, in truth, has equipped itself fully for the responsibilities of increasing productivity. It has been suggested that a national industrial advisory council could prove more effective than the National Production Advisory Council on Industry and the National Joint Advisory Council in exercising a constant stimulus on individual industries and individual concerns, by offering advice or exerting pressure in the cause of greater efficiency or larger production; such an experiment might be worth trying.

No aspect of human relations is more important than that of establishing the closest possible contact between management and the workers, and of discovering and utilizing fully the most effective means of explaining to the latter what is involved in regard to problems that beset their particular industry and firm and those of the country. No step that promises to improve the communications between the Governments, managements and the workers should be left untaken, and there is still much to be done in this field to which Prof. Elton Mayo directed attention in his last book. But the problem is ultimately one of leadership; no amount of exhortation, and no form of organisation can make good defect of leadership, with all it connotes in coherent policy and the vigorous but imaginative translation of policy into practice.

SIR PHILIP HARTOG

P. J. Hartog

A Memoir. By his Wife, Mabel Hartog. Pp. viii+178+6 plates. (London: Constable and Co., Ltd., 1949.) 10*s*. net.

THE publication of this excellent and well-written biographical memoir of the late Sir Philip Hartog will be welcomed by all who knew him personally, and no less by that far greater number who knew his work in one or other of the many fields in which he achieved distinction.

The opening chapter recalls a bygone age in the university life of Western Europe, when Hartog studied in Manchester under Roscoe, Schorlemmer, Balfour Stewart and Schuster, under Friedel, Lippmann and Würtz at the Sorbonne, under Bunsen in Heidelberg and Marcelin Berthelot in the Collège de France. It recalls other days in that great period; for in Paris Hartog lived with his brother-in-law, Arsène Darmesteter, the greatest authority of his time in Old French, and at his house he met and came to know well Renan, Gaston Paris, Paul Meyer, Michel Bréal, Louis Havet, Gabriel Lippmann the physicist, the Dieulafoys who excavated Susa, and James Darmesteter the orientalist, while he was a close friend of Bergson and was offered lessons on the piano by Pachmann. There are many interesting stories here of student life in Paris and Heidelberg in the 1880's, and some illuminating comments on France and Germany from Hartog's letters.

The next chapter, on Hartog's years in Manchester 1889–1903, first as Bishop Berkeley fellow in chemical physics in Owens College, then as assistant lecturer and demonstrator in chemistry and later as secretary of the University Extension Scheme of the Victoria University, is no less interesting; it brings back to mind the days of H. B. Dixon, Samuel Alexander and Tout in the University, and of W. T. Arnold, C. F. Montague and C. P. Scott of the *Manchester Guardian*, to which over many years Hartog contributed scientific articles, leaders and reviews. Here also he met Michael Ernest Sadler, one of the determining influences in his life.

The succeeding chapter deals with Hartog's work as academic registrar of the University of London, 1903–20, and there is much here of the history of the University of London during the period when it developed from being a mere examining body with candidates, rather than students, into a university concerned with students and charged with the duty of providing for teaching and research. As these pages show, Hartog throughout his long and eventful period of office was inspired by the aim of helping to build a university worthy of the greatest city in the world.

The fourth chapter describes Hartog's pioneer work in the foundation of the School of Oriental Studies and his life-long devotion to its interests; and the following three chapters deal with his great services to higher education and administration in India. The eighth chapter covers the years 1930–39, and describes Hartog's wide range of activities during his so-called 'retirement', including his remarkable contributions to the history of chemistry and his return to the study of the problem that had attracted him for many years, the first results of this study being published in 1935 as "An Examination of Examinations", the appearance of which caused considerable discussion. The next chapter deals with his long campaign for the better teaching of English, from his early days in Manchester to the posthumous publication of his "Words in Action". A final chapter describes his last years and his heavy labours during the Second World War; it is followed by an epilogue quoting various tributes to his memory and a bibliography of his writings.

Lady Hartog is to be congratulated on the skill and conciseness with which she has portrayed the life and work of a great and rare personality.

D. McKie

BRITISH VEGETATION

Britain's Green Mantle

Past, Present and Future. By A. G. Tansley. Pp. xii + 294 + 70 plates. (London: George Allen and Unwin, Ltd., 1949.) 18*s*. net.

BY the layman the preservation of the flora and fauna is too often regarded as the concern of the man of science alone, since the contribution that the wild plant and animal life make to his enjoyment is either entirely unapprehended or only vaguely appreciated. A wider knowledge by the general public of the nature and diversities of wild life would do much to inculcate a realization of the part which Nature plays in providing the aesthetic enjoyment of the many who have little or no technical appreciation.

In this work Prof. A. G. Tansley has presented a picture for the layman of the vegetation covering of Great Britain that is at once informative and readable, though at times perhaps somewhat academic for the public to whom it is addressed. The treatment is deliberately restricted to the wild or semi-natural communities, the communities of arable land and artificial forests being omitted.

The first two chapters trace in outline the main changes in vegetation corresponding to the climatic fluctuations from early post-glacial to historic times and those wrought by the influence of man during the last millennium. There follow chapters on the various factors affecting the nature of the plant covering, such as climatic and soil conditions and the influence of animals. In the latter connexion the author gives a well-balanced picture of the role of the rabbit and the part it plays in the economy of to-day, a realization of which is an essential preliminary to any action that may be taken to deal with this menace. There follow chapters on conventional lines describing the woodland, grassland, moorland, mountain, freshwater marsh and maritime vegetation in which technical terms are mostly avoided, and any well-educated person should be able to peruse these pages with interest and profit. The work is profusely illustrated with photographs of vegetation which are of varied merit, both as to their technical quality and as illustrating the text.

E. J. SALISBURY

MICROWAVE AERIALS

Microwave Antenna

Theory and Design. Edited by Prof. Samuel Silver. (Massachusetts Institute of Technology: Radiation Laboratory Series, Vol. 12.) Pp. xviii+623. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 48*s*.

Radar Scanners and Radomes

Edited by W. M. Cady, M. B. Karelitz and L. A. Turner. (Massachusetts Institute of Technology: Radiation Laboratory Series, Vol. 26.) Pp. xvi+491. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 42*s*. net.

THESE books are two further volumes of the comprehensive series on radar and related techniques prepared at the Radiation Laboratory of the Massachusetts Institute of Technology. Readers of these columns will already be aware of the general scope and aim of this series from earlier reviews of previously published volumes.

The microwave region is the transition stage from that part of the electromagnetic spectrum where the wave-length is large compared with all the components of a given system, as in ordinary broadcasting, to the optical region in which wave-lengths are much smaller than any apparatus involved in their application. The microwave region is also a transition region as regards theoretical methods of analysis. Such methods range from lumped-constant circuit theory on the low-frequency side, through transmission-line theory, field theory and diffraction theory to geometrical optics on the high-frequency side. In the study of microwave aerials there is frequent need for using several of these theoretical processes in parallel—combining field theory and transmission-line theory, supplementing geometrical optics by diffraction theory, and so on.

The very great use made during the Second World War of the microwave portion of the radio-frequency spectrum stimulated the development of several new types of aerial, and Volume 12, on "Microwave Antenna: Theory and Design", is intended to give a systematic treatment of the basic principles underlying the design of such aerials. After a brief introductory chapter giving a broad survey in general terms of the various types of microwave antenna, and of the kinds of design problem involved in making an aerial system to give a radiation pattern of a specified shape, the remainder of the book falls into four main divisions: basic theory, theory and design of feeds (the primary radiators), theory and design of complete antenna systems and, finally, the techniques and equipment required in the measurement of the performance of such systems.

A summary is given in Chapter 2 of certain parts of conventional circuit theory pertinent to antenna problems: as a consequence of reciprocity between the transmitting and receiving patterns of an aerial, there follows the important practical result that no distinction need be made between the transmitting and receiving functions of the aerial in design problems. The basic principles of field theory and a discussion of current distributions as sources of radiation fields follow in Chapter 3. Chapter 4 is concerned with a treatment of the properties of wave-fronts and rays, and Chapter 5 with the interaction between electromagnetic waves and obstacles; here the general theory of reflectors is developed as a boundary-condition problem, and the relation between this approach and conventional diffraction theory is discussed.

A complete microwave antenna system most frequently consists of a primary radiator—involving perhaps a single dipole, or some array of dipoles, or a horn terminating a wave-guide, or some configuration of slots in the side of a wave-guide—which illuminates a secondary radiator in the form of, say, a specially shaped reflecting mirror or, in other cases, some type of lens. The relation between the field distribution over the aperture of such a lens or reflector and the secondary radiation pattern is one of the fundamental problems of antenna design and is dealt with in Chapter 6.

Chapter 7, on microwave transmission lines, serves as introduction to several further chapters (8, 9 and 10), on antenna feeds, the primary radiators: these chapters cover dipole feeds, linear arrays, and horns. The last two types are also used themselves, on occasion, as complete aerials. It might be noted at this point that Dr. G. G. Macfarlane, of the Telecommunications Research Establishment, was one of the authors of Chapter 9, and, in particular, was responsible for the theoretical discussion on slot radiators. Dr. Macfarlane also reviewed critically several of the theoretical chapters: in these matters at least, therefore, we may expect the book to contain a reasonably balanced account of American and British work. The same is not true of all the subject-matter unfortunately, for, although it was the original aim to produce such a balanced account, the editors state that it proved too ambitious an undertaking; the references are therefore principally to American developments.

Radio lenses, both of the dielectric and metal plate types, are considered in Chapter 11; the tolerances in design are discussed. This is quite a short chapter, and is now, unfortunately, scarcely up to date, for much important work has been done in

this field since the present book was prepared. More complex antenna systems are described in the next two chapters, and their development is considered in terms of the specific final radiation patterns required. The types of pattern discussed include the pencil-beam, simple fanned-shape beams, and modified beams of the latter kind desirable, for example, for either surface-based or for airborne radars required to search for targets over specified regions of space. There is here included a treatment of the impedance characteristic of such aerials and of associated matching problems.

Chapter 14 is concerned with some of the difficulties likely to be encountered by engineers in the installation of microwave aerials, whether on the ground or in ships or aircraft. Finally, in the last two chapters, 15 and 16, the techniques and equipment used in the measurement of the characteristics and performance of aerials are described. The range of topics covered includes methods for the measurement of impedance, and for the determination of the characteristics of the primary feed, and also of the radiation pattern and gain given by the secondary radiator. The items of equipment described include signal generators, detectors and associated amplifiers, and instruments for the automatic recording of antenna radiation patterns.

The second volume, No. 26 of the series, on "Radar Scanners and Radomes", deals mainly with the engineering aspects of the design of scanners and their housings. The editors state that: "The treatment is incomplete in two respects. There is almost no reference to equipment operating at wave-lengths greater than 10 cm., and there is little discussion of scanners not developed at the Radiation Laboratory. These omissions, particularly the latter, should not be regarded as an indication of editorial complacency; they result from lack of information by the authors." The reader should therefore not expect to find any reference to the considerable British work in this field.

The volume is divided into two parts: Part 1, on the subject of scanners, is written largely for the mechanical engineer; while in Part 2, on radomes, electrical considerations predominate. Part 1 contains eight chapters, and begins with a review of the elements common to all scanners and a general discussion of the design problems involved. The types of scanner used in aerials for ground-based and for shipborne and airborne radar equipments are then treated separately and in considerable detail. Chapter 4 deals with the important question of the stabilization of aerials mounted on ships, and the corresponding problem in the case of airborne antennæ is examined in Chapter 7. The final chapter of Part 1 contains a discussion of the manner in which aerials are controlled in order to achieve the desired scanning performance; this involves some considerations of the principles underlying the operation of servo mechanisms. A number of actual American equipments are described, and the text is most liberally illustrated by photographs and detailed diagrams which, together with a wealth of practical design information, should be of great use to engineers with construction problems of a similar nature.

The installation of a microwave radar scanner involves not only mechanical but also electrical problems. Thus, difficulty is sometimes experienced with an airborne radar antenna because aerodynamic requirements dictate that it be mounted close to the metal structure of the aeroplane. Such an antenna must also be provided with a rigid housing—or radome, as it is called—to protect it from large aerodynamic loads, and to avoid disturbance of the control of the aircraft. A ground-based or shipborne aerial may also require a housing for protection against wind forces. Part 2 of Volume 26 deals with the principal factors which enter into the design of radomes. Since the wall thickness of a radome is necessarily of the same order of magnitude as the wave-length of the radiation involved, there is appreciable reflexion and absorption of radio-frequency energy by a radome: the design of any such housing must therefore comply with certain electrical requirements as well as with structural and mechanical ones.

A general survey of the radome design problem is given in Chapter 9. It is often possible to arrange the shape of a radome to be such that, during the whole of the scanning process, the radiation traverses the wall of the dielectric housing at approximately normal incidence. This type, which includes all radomes of ground-based and shipborne radar sets, is discussed in Chapter 10. On the other hand, it is often necessary, and always desirable, to streamline the radome of a set installed in a fast aircraft. In such cases the normal-incidence design may introduce an intolerable amount of drag. Chapter 11 is therefore devoted to a consideration of the kind of housing required for fast aircraft, where the range of angles of incidence of the radiation at the radome wall may vary from 0° up to at least 70°. The theory of the reflexion and transmission of electromagnetic waves by dielectric materials, including the important case of 'sandwiches', is considered in Chapter 12. A sandwich radome is one in which several layers of different dielectric materials are used: such a procedure allows greater flexibility in design than does the use of a single dielectric, and also enables the weight of the housing, for a given strength, to be kept to a minimum.

The mechanical, thermal and electrical properties of the materials most useful for radomes are discussed in Chapter 13, where there is also some information about fabrication and testing. In the final chapter, 14, various types of radome now in use are considered, and the methods followed, and equipment required, in the testing of their electrical and mechanical performances are described.

While one might criticize these volumes on points of detail, it scarcely seems an appropriate thing to do, for it must be remembered that the main aim of the Radiation Laboratory Series has been to make generally available, as quickly as possible, a vast amount of information gained during the war years. This has meant that many authors have contributed to each volume, and that some discontinuity of style must be expected: it is, in fact, remarkable that the editors have been able in so many cases to make the discontinuity scarcely apparent. One is therefore prepared to overlook minor defects in matters of presentation which might be regarded less favourably in a work produced under better conditions. It may then be said that these two books form a worthy addition to the Radiation Laboratory Series. They provide an admirable basic reference text for anyone interested in the design of aerials for microwave applications, although it should be borne in mind that this is a field in which considerable progress has been made recently, and that many important developments of the past two or three years can still only be found in original papers. J. A. Saxton

A New Notation and Enumeration System for Organic Compounds

By Dr. G. Malcolm Dyson. Second edition. Pp. ix+138. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1949.) 10*s*. 6*d*. net.

WHILE the main general principles of the original notation are retained in this second edition, some changes have been made, and the new edition is offered as a definitive proposal for an international system for delineating and enumerating organic structures. In the description of ring systems the principle of adduction is abandoned in favour of a more logical statement of the reticular system. Suggestions made by Dr. A. M. Patterson for reconciling the logic of the new notation with that of the ring index, and with suggestions of Dr. F. L. Taylor for ring citation, are incorporated in the section dealing with fused rings. Another major revision is the rearrangement of symbols within the operations, which is intended to facilitate indexing and the manipulation of punched card data.

Besides these changes, the book has been considerably enlarged, and its layout is a great advance on the first edition. The chapter on difficulties of existing nomenclature is better balanced and forms an admirable introduction. This is now followed by a chapter giving a clear and concise introduction to the procedures of the cipher, indicating how it may be applied to the majority of comparatively simple compounds. A full analytical discussion follows in the next four chapters, which deal successively with the basic carbon skeleton, the heterocyclic compounds, functional groups and with complex heterogeneous structures, polymers, carbohydrates and proteins. The concluding two chapters deal with the relation between cipher and spoken nomenclature and with computation and the mechanical use of the notation.

A very large amount of new work has gone to the preparation of this edition, and the clear presentation should facilitate its consideration by the general body of organic chemists. Whether or not the system is internationally adopted or widely used, Dr. G. M. Dyson has assuredly earned the respect and gratitude of the organic chemist for a most pertinacious attack on a complex if not intractable problem. R. B.

Between Pacific Tides

An Account of the Habits and Habitats of some Five Hundred of the Common, Conspicuous Seashore Invertebrates of the Pacific Coast between Sitka, Alaska, and Northern Mexico. By Edward F. Ricketts and Jack Calvin. Revised edition. Pp. xxvii+365+46 plates. (Stanford, Calif.: Stanford University Press; London: Oxford University Press, 1948.) 32*s*. 6*d*. net.

MESSRS. E. F. RICKETTS and J. Calvin have revised their well-known book on the littoral fauna of the west coast of America. Written by laymen collectors for the layman, it stimulates his curiosity about the prolific life of the sea-shore and deals with the subject from the ecological rather than the taxonomic point of view. Animal communities of the protected outer coast, open coast, bays and estuaries, and wharf piles are described, each area being again subdivided according to the substratum. These chapters are illustrated by photographs from living animals, making forty-six plates, and 129 line-drawings. A few of the plates (for example, 39, 43) have lost somewhat in brightness; but the magnificent colour-plate of Pacific chitons, on its green background, which forms the frontispiece, is a most attractive and useful addition. The littoral section has cross-references from text to plate and vice versa. The original text remains unaltered, except for the correction of minor errors.

The addenda consist of a chapter on plankton and a complete revision of the extensive bibliography. The former is more advanced in style than the popular portion of the book and contains many graphs showing seasonal changes in the phytoplankton and zooplankton, but no sketches or photographs of the living organisms. Surely the amateur needs some pictorial help on this subject, if he is to be able to link it up with the earlier section of the book? The foreword is written by John Steinbeck.

The Antarctic Ocean

By Russell Owen. Pp. 225+14 plates. (London: Museum Press, Ltd., 1948.) 18*s*. net.

THE author of this book caught the fascination of the Antarctic when he went south with R. E. Byrd in the *Little America* expedition of 1928–30 as special correspondent of *The New York Times*. He has retold the stories of some of the best-known expeditions of all times with an eye to journalistic interest rather than historical value. There is little new and practically nothing about the Antarctic Ocean, and very little about the Antarctic Continent, its glaciers and animal life. Mr. R. Owen is cautious about the Bransfield Palmer controversy over the discovery of what is now known as Graham Land, but he goes too far in asserting that C. Wilkes furnished proof of the continental character of Antarctic lands. There is very little in his pages about recent British and Norwegian work. Two dozen sketch-maps are a useful feature of the book. R. N. R. B.

Subject Index to Periodicals, 1947

(Issued by the Library Association.) Pp. xi+311. (London: Library Association, 1949.) £5 5*s*. 0*d*.

THE principal change in this valuable work for the general reader is the change in size from quarto to a format which allows it to be shelved with the majority of other reference books. It is compiled on the plan of the 'dictionary catalogue', and the cross-references increase its value in tracing references to unusual and out-of-the-way topics which might otherwise be overlooked. While it does not cover the highly specialized periodicals of which the contents are covered by sectional indexes or abstracts, the scientific worker will sometimes find it a useful supplement to such sources in completing a search, particularly on more general topics.

A New Dictionary of Chemistry

Edited by Dr. Stephen Miall and L. Mackenzie Miall. Second edition. Pp. ix+589. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1949.) 60*s*. net.

IN this second edition of a well-known work, an opportunity has been taken to make many corrections in the original text, and to add much new material to bring it up to date. The book is intended to be a handy work of reference, and it should serve this purpose excellently. The reviewer notices that the sections include atomic energy, penicillin, streptomycin and pterins, but not lithium aluminium hydride, promethium and osmium carbonyl, to take a few examples at random. This dictionary should be in all school and college libraries. J. R. P.

GROUNDNUT SCHEME IN EAST AFRICA

READING the first annual report and accounts for 1948–49 of the Overseas Food Corporation*, the reader gets the impression that the high hopes with which the East African groundnut scheme was launched faded rapidly. Certainly, not only the hopes but also the scheme itself would have gone had not the Corporation been able to call, to the tune of £23,000,000, on the apparently bottomless purse of the British Treasury. Of this sum, about £14,000,000 is represented in the accounts by fixed and current assets, and £9,000,000 by "development, land clearing and agriculture". For the expenditure of the latter sum no return has yet been obtained. During the year 1948–49, 50,000 acres were sown to groundnuts and sunflowers, instead of the 600,000 originally planned; but the clearing of the 50,000 acres cost nearly as much as the clearing of the 600,000 acres was expected to cost. Incredible miscalculations were made, and experience was bought at heavy cost to the taxpayer. Nevertheless, a beginning has been made which, had the scheme been laid down on a more moderate scale and carried out less extravagantly, would have been considered a good one. The report strengthens the opinion held in many quarters that the correct procedure would have been to gain experience on a 'pilot-plant' scale before launching out on to the perilous and uncharted seas of large-scale production. The work of the Scientific Department, established in January 1947, would probably also have benefited by being concentrated on a pilot plant instead of covering the whole field of actual operations, although it is clearly too early to assess research results after only two years.

The report of the Scientific Department occupies about a third of the whole annual report, and deals with the period from its inception in January 1947 to the end of the 1947–48 crop season. The first duty of the chief scientific officer (Dr. A. H. Bunting) was defined as the carrying out of research and the collection of scientific data to form the basis of the agricultural and soil-conserving measures to be used. "The first object is the institution of agricultural methods capable of giving maximum yields consistent with the maintenance of soil fertility. Investigation of the production of other food crops will have to be pursued concurrently, both to feed the personnel and as a basis for the future developments outlined in the [Wakefield] Mission's report, should these be undertaken." At present, matters involving animal husbandry are excluded from the Department's purview, though as the inclusion of animal husbandry in the agricultural system becomes possible it is expected that problems of mixed farming will be studied.

During the period under review, the Department's staff consisted of the chief scientific officer, a chemist, three soil surveyors, an analyst, an agronomist, a statistician and an entomologist. Work done consisted principally of rapid reconnaissance surveys of areas proposed for development, soil-fertility and fertilizer studies based on the surveys, experimental work on groundnuts and other crops, preliminary surveys of insect and disease attacks on groundnuts, etc., and laboratory work on soils and the determination of the oil content of oil seeds.

The surveys were of necessity exploratory. The soils, however, were described in general terms, but with sufficient detail to distinguish the major types, and test crops were grown on some soils to get an idea of their productivity.

Numerous soil analyses have shown that all the soils at the main centre of operations at Kongwa are poor in phosphates and nitrogen, but rich in potash. It was expected, therefore, that groundnuts would respond to phosphate but not to potash, and the first fertilizer experiments have confirmed this. A small positive response was obtained to nitrogen alone, but a negative response when nitrogen was applied with phosphate. Responses to both nitrogen and phosphate were enhanced by placing the fertilizer in bands to the side of the seed instead of broadcasting, but the conclusion drawn is that probably only phosphate will give an economic return at Kongwa. Other crops, such as sunflower, likely to be grown will probably require nitrogen also.

Soil conservation is said not to be the duty of the Scientific Department; nevertheless in so far as the Department is concerned with the development of a scientifically based, stable system of agriculture, it will encounter problems of soil conservation at every turn. Soil erosion has not yet become a serious problem, and at Kongwa it was effectively controlled by laying out level contours in the cleared ground and piling the cleared debris in windrows on the contours. This is a temporary measure which it is expected will be superseded by a system of broad-based contour terraces.

Experiments were initiated to determine the effects on groundnut yield of such factors as plant variety, plant population, time of planting, and methods of cultivation and harvesting. Although the results for one season will require confirmation, definite indications were obtained that early planting is necessary to obtain the highest yields. The oil contents of different varieties tend to vary inversely with the yields, so that the yield of oil per acre does not vary much from one variety to another. Varieties with an upright growth have the lowest yield of kernels with the highest oil content.

In the original White Paper on the scheme, a rotation of two years of groundnuts followed by two years of grass ley to restore soil fertility was suggested. It appears to be unlikely that this suggestion will be adopted immediately, mainly because ley farming, to be economic, involves the building-up of livestock herds to utilize the ley, and of water supplies. In 1948 sunflowers were the only crop other than groundnuts to be grown on a large scale, and, indeed, were sown on an almost equal acreage. They appear to be a promising alternative oil crop, in some respects more reliable than groundnuts. For future planning, a rotation of groundnut, sunflower and a grass resting-crop was assumed at the time the report was written. Tests with many other crops were made by the Scientific Department, the ultimate objective being to develop systems of farming suited to the varying conditions in which the Corporation is interested.

* Overseas Food Corporation. First Annual Report and Statement of Accounts for the Period ended March 31, 1949. Pp. vi+158. (London: H.M. Stationery Office, 1949.) 3s. 6d. net.

Work on plant protection was confined chiefly to entomological investigations, the most serious threat to groundnut production coming from the presence of *Hilda patruelis*. It is expected that the virus causing rosette will cause trouble in the near future; but in the 1948 season diseases do not seem to have been serious.

Investigations on the quality of the groundnut oils produced at Kongwa by Prof. T. P. Hilditch, of the University of Liverpool, showed that they were of very high quality, and in colour and free acidity they "far surpass any raw groundnut oil which has hitherto been on the English market". The oils had an exceptionally high iodine value, but were liable to deteriorate in presence of moisture.

An Operational Research Unit was established in 1949 to carry out research on land-clearing, agricultural, civil-engineering and transport problems, as it had been found that tests made in England on plant and equipment had little value for East African conditions. The Unit has had considerable success in developing a chain-cable clearing of bush. A heavy 3-inch chain cable is attached to two heavy tractors which move through the bush 20–30 ft. apart, and a third tractor follows to deal with particularly stout trees which the chain cable cannot pull out of the ground. The successful application of this method of flattening is cited as the outstanding achievement of the year, and promises to effect great economies in the cost of clearing, although at Kongwa it has considerably increased the wastage of tractors.

G. V. Jacks

INFLUENCE OF ORGANIC NITROGEN COMPOUNDS ON NITRIFICATIONS IN SOIL

By Prof. J. H. QUASTEL, F.R.S.
AND
Dr. P. G. SCHOLEFIELD
Montreal General Hospital Research Institute, Montreal

THE following report is intended to summarize briefly some of the main findings discovered in an investigation of the metabolism of organic nitrogen compounds in soil, with particular reference to the breakdown of amino-acids and certain allied substances. They throw light on the problem of the interference of organic matter with soil nitrification and on the chemical nature of a number of molecules that appear specifically to affect ammonia metabolism. They also point to the presence in soil of a class of organisms that can convert certain organic nitrogen compounds directly into nitrites. This report must be regarded as a preliminary statement; full details of the experimental techniques and results (together with many that cannot adequately be mentioned here) will be given in later publications.

The method of investigation is that of continuous perfusion of a solution of the substance under investigation through a column of 30 gm. air-dried crumbed soil, under conditions where optimal aeration together with water saturation, but no waterlogging, occurs. This method of soil perfusion has already been fully described by Lees and Quastel[1] in their studies of nitrification in soil; but the apparatus now used is Audus's modification[2] of the original one used by the above workers. Among the various conclusions reached by Lees and Quastel the following bear upon the subject of the present inquiry.

(1) When nitrification takes place in a soil, the nitrifying organisms develop largely on the surfaces of the soil crumbs. During the initial perfusion of an air-dried soil this process may be of long duration, since the logarithmic growth phase is involved; but eventually a condition arises when the sites of proliferation on the soil are saturated with the nitrifying organisms. The soil is then termed a saturated or enriched soil. Such a soil brings about a relatively rapid rate of nitrification, and this rate remains constant during subsequent perfusion of the soil with ammonium chloride. The soil, in fact, behaves like an enzyme system, no proliferation of the relevant organisms taking place except presumably to replace the dead cells.

(2) A saturated soil that nitrifies an ammonium salt at a constant rate and shows no initial lag period will not nitrify organic nitrogen compounds such as methylamine, trimethylamine and glycine at constant rates. A lag period occurs, showing that organisms must first develop that can convert these compounds into free ammonia which is afterwards nitrified. On the other hand, it was found that nitrification of pyruvic oxime shows little or no lag, and it seemed possible that this molecule may play a significant part in the process of nitrification.

Nitrification of Ammonium Chloride and Glycine

If the conversion of glycine into nitrate by soil bacteria always requires the intermediate production of the ammonium ion, it follows that the rate of nitrification of glycine should never exceed that of ammonium chloride, under identical experimental conditions and for equal quantities of nitrogen. Experiment, however, shows that this is not always the case. A few typical results are shown in Table 1.

Table 1

Garden soils	pH	μgm. NO_3'-Nitrogen/ml. formed on continuous perfusion at 70° F. Maximum possible = 140 μg n./ml.			
		Ammonium chloride (0·01 *M*)		Glycine (0·01 *M*)	
		First perfusion (15 days)	Second perfusion (13 days)	First perfusion (15 days)	Second perfusion (13 days)
I	4·5	10	—	10	—
II	6·5	82	18	134	98
III	7·6	113	104	140	78

Here it will be seen that with a soil of *p*H 6·5 the rate of nitrification of glycine exceeds that of ammonium chloride and that such a soil on perfusion with glycine may become enriched with nitrifying organisms while the same soil perfused with an equimolar solution of ammonium chloride fails to show such an enrichment. A neutral or slightly alkaline soil, on the other hand, favours the nitrification of ammonium chloride rather than that of glycine, while a distinctly acid soil (*p*H 4·5) fails to nitrify either molecule satisfactorily. The phenomenon whereby a slightly acid soil (and many agricultural soils are of this nature) brings about a preferential nitrification of an organic nitrogen compound such as glycine must, of course, be of

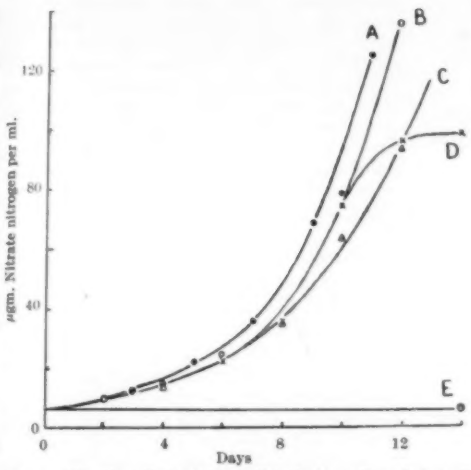

Fig. 1. Kinetics of nitrate formation during soil perfusion of ammonium chloride and amino-acids
A, 0·01 *M* ammonium chloride; *B*, 0·01 *M* glycine; *C*, 0·01 *M* alanine; *D*, 0·01 *M* glutamate; *E*, 0·01 *M* methionine

importance in agricultural practice and should be considered in connexion with fertilizer problems. The reason for this preferential nitrification of glycine rather than of ammonium chloride is not difficult to discover.

When nitrification of one ammonium ion takes place, two hydrogen ions are liberated, thus:

$$NH_4^+ + 2O_2 \rightarrow 2H^+ + NO_3^- + H_2O.$$

Unless, therefore, the medium in which nitrification takes place is well buffered, the process must eventually cease on account of the decreased *p*H. The optimal *p*H for nitrification (in pure culture), as Meyerhof[3] has shown, is *p*H 8. When glycine is nitrified the following is the end result:

$$^+NH_3.CH_2.COO^- + 7(O) \rightarrow 2CO_2 + 2H_2O + H^+ + NO_3^-.$$

In this case, only one hydrogen ion is liberated per molecule of glycine apart from the production of carbon dioxide, and hence the production of acidity will not be as great as in the nitrification of an ammonium salt of a mineral acid.

It follows, if this reasoning is correct, that the administration of sodium bicarbonate or calcium carbonate with ammonium chloride should serve to neutralize the acids formed during nitrification and prevent any decrease in the rate of this process. Results given in Table 2 show the truth of this conclusion, which is, of course, already well known in agricultural practice. Simple admixture of the soil with calcium carbonate will convert a soil that poorly nitrifies ammonium chloride into a rapidly nitrifying soil which easily becomes saturated. Further experiment shows that admixture of the substrate with the sodium salts of organic acids such as acetic, pyruvic and succinic, has the same effect as admixture with sodium bicarbonate; that is, that of preventing too great an increase of acidity during nitrification due to the formation of sodium bicarbonate, and therefore of apparently stimulating nitrification of ammonium salts of mineral acids. It is evident that on slightly acid soils the salts of organic acids do not necessarily depress the rate of nitrification; on the contrary, they may favour it.

Table 2

μgm. Nitrate nitrogen/ml. formed on continuous perfusion at 70° F. Local garden soil. Maximum = 140 μgm./ml.

Perfusate	First perfusion (7 days)	Second perfusion (3 days)	Third perfusion (3 days)
Ammonium chloride (0·01 *M*)	67	15	9
Ammonium chloride (0·01 *M*) and sodium bicarbonate (0·01 *M*)	93	30	—
Ammonium chloride (0·01 *M*) and 1 gm. calcium carbonate added to soil	125	99	98

Recovery of Organic Nitrogen as Nitrate during Soil Nitrification

While the recovery of the nitrogen of the ammonium salt of a mineral acid as nitrate during the continuous perfusion through soil is very nearly 100 per cent, this is not the case with the nitrogen of α-amino-acids. Typical results shown in Table 3 indicate that the recovery decreases with increase in the C/N ratio of the amino-acid. This conclusion is to be expected as the heterotrophic organisms proliferating at the expense of the amino-acid must use part of the nitrogen for their development. The greater the quantity of carbon available for proliferation purposes, the greater will be the quantity of nitrogen which will be used to support this proliferation. Hence the smaller will be the quantity of nitrogen which will be available as ammonia for the disposal of the nitrifying organisms. This is an illustration of the well-known fact that the presence of assimilable carbon in the soil diminishes the availability of ammonia or nitrate nitrogen to the plant.

Table 3

Percentage recovery of perfused organic nitrogen as nitrate nitrogen on continuous perfusion through soil at 70° F. for 15 days
Maximum absolute recovery possible = 140 μgm./ml.

Source of nitrogen	Recovered as nitrate nitrogen (μgm./ml.)	Percentage recovery
Ammonium chloride	138	98·5
Glycine	135	96·5
dl-Alanine	118	84·0
dl-Sodium glutamate	95	68·0

Rates of Nitrification of Amino-Acids in Soil

The rates of nitrate formation from such amino-acids as glycine, alanine and glutamic acid on continuous perfusion through a well-buffered garden soil (*p*H 7·2) do not differ markedly from that from ammonium chloride when used at equivalent concentrations. Some results are shown in Fig. 1. This would indicate that in spite of the development of heterotrophic organisms which capture part of the available nitrogen, sufficient ammonia is produced to encourage the proliferation of nitrifying organisms at nearly optimal rates. Such a result proves that, under soil conditions, the presence of organic matter, in the form of the simple amino-acids quoted, is no hindrance to the process of nitrification. The initial lag periods in the course of nitrification of the three amino-acids are of the same order as that of ammonia itself.

An entirely different picture presents itself when *dl*-methionine is studied. It suffers no nitrification even after fourteen days continuous perfusion (see Fig. 1).

Selective Inhibitory Action of *dl*-Methionine on Nitrification

Dl-methionine has a highly inhibitory effect on the nitrification of ammonium ions in soil. In an experiment in which the rate of ammonium ion conversion into nitrite, during soil perfusion, was investigated by means of the addition of 0·001 *M*

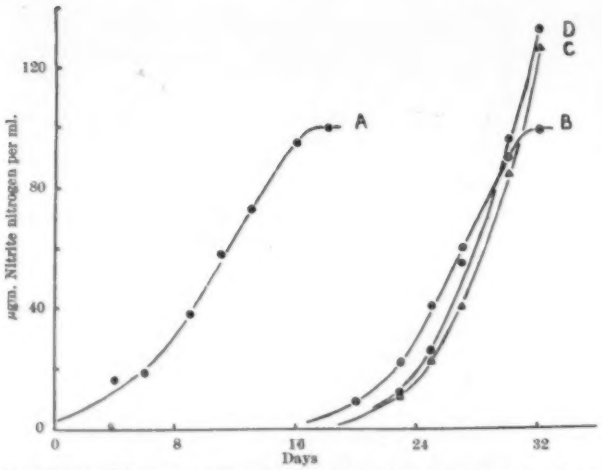

Fig. 2. Effects of *dl*-methionine on the kinetics of nitrite formation during soil perfusion *A*, (0·01 *M*) ammonium chloride; *B*, (0·01 *M*) methionine; *C*, (0·01 *M*) methionine + (0·01 *M*) ammonium chloride; *D*, (0·01 *M*) methionine + (0·01 *M*) glycine

potassium chlorate, which prevents the development of *Nitrobacter*[4], it was found that *dl*-methionine (0·005 *M*) greatly retards the rate of nitrite formation from ammonia or glycine. Only when, eventually, methionine itself is broken down, does nitrite appear from the ammonium ions or from glycine. These results are illustrated in Fig. 2. It is evident from this result that *dl*-methionine represents an organic molecule having a highly inhibitory effect on the ammonia metabolism of *Nitrosomonas*. The mechanism of this inhibition awaits further investigation.

Inhibitory Action of Thiourea on Nitrification

Further work has shown that thiourea exerts an even more profound inhibitory effect than *dl*-methionine on the nitrification of ammonia in soil. Results given in Fig. 3 show that thiourea at a concentration of 0·00033 *M* will entirely prevent the nitrification of ammonium chloride even after a lapse of sixteen days. No indications have been obtained as yet that thiourea itself will undergo nitrification or will permit this process to take place in its presence.

Amino-Acids and Nitrite Oxidation in the Soil

The presence of α-amino-acids tends to retard the rate of disappearance of admixed nitrite (0·01 *M*) when continuously perfused through soil (see Fig. 4). The retardation by glycine, alanine or sodium glutamate is not large and may perhaps be explained on the grounds that the amino-acids themselves give rise to sufficient nitrite, as an intermediate in their oxidation, to maintain the initial nitrite-level for some time. Cysteine produces a greater retardation, but *dl*-methionine again evinces a highly inhibitory effect on this aspect of nitrification. Eventually, after about ten days, nitrite metabolism takes place even in the presence of *dl*-methionine which, itself, has not yet suffered decomposition. It would follow that the nitrite-oxidizing organisms may adapt themselves to the inhibitory action of the methionine. This phenomenon of the adaptation of nitrite-oxidizing organisms to a variety of toxic substances will be the subject of another communication.

Inhibitory Effects of Ethyl Urethane

As shown by Meyerhof[3] working with pure cultures of nitrifying organisms, and by Lees and Quastel[1] in investigating the process of nitrification in soil, ethyl urethane inhibits the conversion of ammonium ions into nitrate. This phenomenon takes place with an enriched soil; so it would appear that urethane is acting as a poison to ammonia metabolism. Typical results showing the effect of ethyl urethane on the nitrification of ammonium chloride in a fresh garden soil are shown in Fig. 5, where results of duplicate experiments are given. The inhibition lasts for about twenty days, and thereafter nitrification proceeds normally except that the nitrate nitrogen recovered accounts for 80 per cent of the total nitrogen of the ammonium chloride and the urethane. This indication that urethane may itself be metabolized by soil organisms has been investigated further, and some evidence has been obtained concerning the method of metabolism. It will be discussed elsewhere.

The effect of ethyl urethane has been shown to be reversible by Lees and Quastel[1], and it is therefore possible that the action is due to competitive inhibition of ammonia metabolism.

It is worth pointing out at this juncture that both ethyl urethane and thiourea, which exert such a profound effect at low concentrations on ammonia

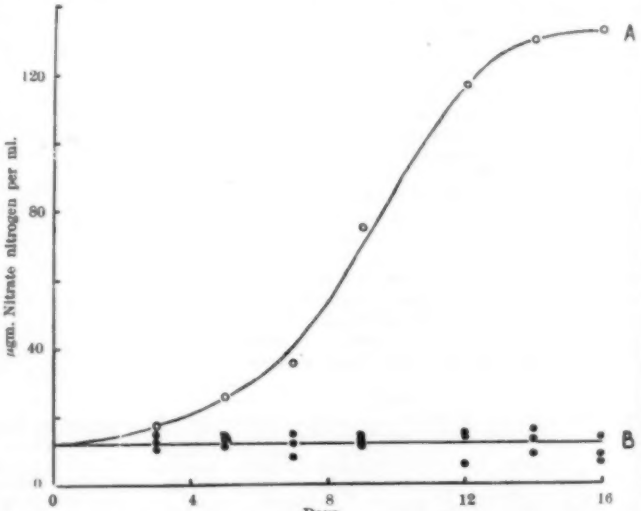

Fig. 3. Effect of thiourea (0·0003 *M*) on nitrate formation from (0·01 *M*) ammonium chloride during soil perfusion
A, Ammonium chloride; *B*, ammonium chloride and thiourea

metabolism of nitrifying cells, are now known to be carcinogens. The mode of action of these substances in the body is quite unknown, but the question arises as to whether it is possible that they may be acting by affecting some phase of ammonia metabolism in animal tissue. This problem is now engaging our attention.

Manometric Studies on Enriched Soils

Soils that have been enriched or saturated with organisms attacking certain substrates may be conveniently investigated by the conventional Warburg manometric techniques. A few typical results will be quoted although details of the technique will be given in full in later papers. It has been possible to show that ammonium salts, and nitrite, take up the expected quantities of oxygen for conversion to nitrate, using the appropriate washed enriched soils as the catalytic agents. The same technique allows the effects of poisons on the enzyme systems of enriched soils to be explored quantitatively. The rate of oxygen uptake by an enriched soil in the presence of the substrate used for enriching the soil with the organisms which metabolize it is usually constant, and the effect of an inhibitor can be assessed with some accuracy. An example of the inhibitory effect of thiourea on the oxygen uptake of a soil enriched with nitrifying organisms in the presence of ammonium ions is shown in Fig. 6.

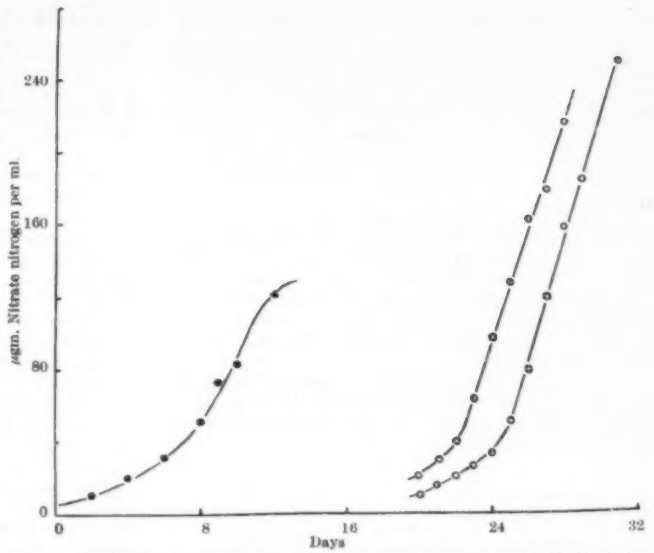

Fig. 5. Effect of ethyl urethane on nitrate formation from ammonium chloride during soil perfusion
● – ● –, 0·01 *M* ammonium chloride; ○ – ○ –, 0·01 *M* ammonium chloride and 0·1% ethyl urethane

Table 4

Rates of extra oxygen uptake by a nitrite-enriched soil at 37° C.

	In c mm./hr.
Sodium pyruvate (0·01 *M*)	34
Sodium nitrite (0·01 *M*)	62
Sodium pyruvate (0·01 *M*) + Sodium nitrite (0·01 *M*)	87·5

On the other hand, the presence of a number of organic molecules such as pyruvate does not influence the rate of nitrite oxidation by the nitrifying organisms. The rates of extra oxygen are additive, or nearly so, on enriched soils, as shown by the results in Table 4.

These results prove that organic matter *per se* does not influence the metabolism of nitrite by the nitrifying organisms.

Manometric experiments have proved to be of great value not only in assessing the activities of enriched soils or in studying the effects of substrates or of poisons in soil processes, but also in investigating the nature of the catalytic systems or enzymes in the organisms that enrich the soil.

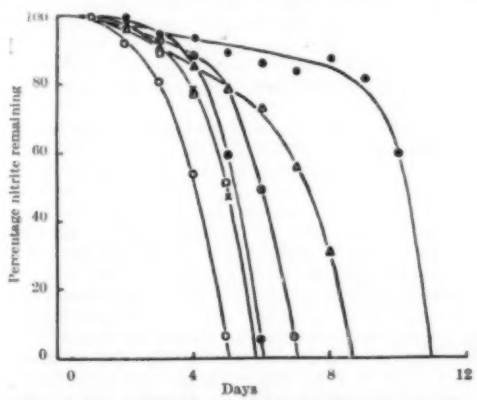

Fig. 4. Effects of amino-acids (0·01 *M*) on nitrite utilization during soil perfusion
o — o —, Nitrite alone; × – × –, with alanine; ○ – ○ –, with aspartate; □ – □ –, with glycine; ⊕ – ⊕ –, with glutamate; △ – △ –, with cysteine; ● – ● –, with methionine

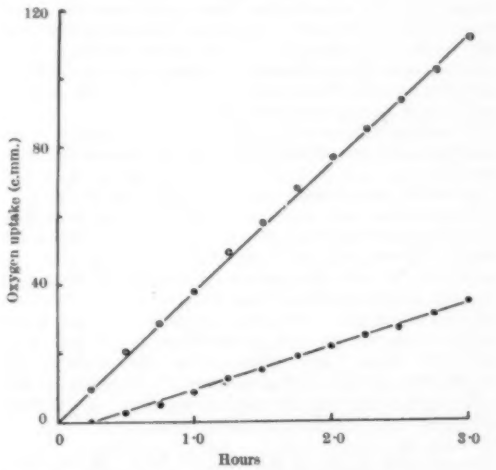

Fig. 6. Effect of thiourea on the oxygen uptake of an enriched soil in the presence of ammonium chloride at 37° C.
○ – ○ –, 0·01 *M* ammonium chloride; ● – ● –, 0·01 *M* ammonium chloride and 0·01 *M* thiourea

Metabolism of Pyruvic Oxime

Pyruvic oxime, as shown by Lees and Quastel[1], undergoes rapid nitrification in soil during continuous perfusion. It was thought by these authors that this molecule might be intermediate in the process of ammonia conversion into nitrate during soil nitrification. This, however, is not the case, since further studies—both perfusion and manometric—have shown :

(*a*) that ethyl urethane and methionine, which inhibit nitrification of ammonia in soil, have no inhibitory effects on the nitrification of pyruvic oxime ; potassium chlorate also has no action.

(*b*) that soils enriched with ammonia- or nitrite-oxidizing organisms cannot oxidize pyruvic oxime immediately though they oxidize ammonium ions or nitrite respectively.

(*c*) that soils enriched with organisms oxidizing pyruvic oxime by continuous perfusion with it cannot oxidize ammonium ions. Typical figures supporting these statements are given in Table 5.

Table 5

(*A*) Pyruvic oxime enriched soil. Oxygen uptakes in 3 hr. in c.mm. at 37° C.

Water	155
Pyruvic oxime (0·01 *M*)	380
Ammonium chloride (0·01 *M*)	155

(*B*) Perfusion of ammonium chloride enriched soil. Percentage nitrogen appearing as nitrite in 24 hr. 0·001 *M* potassium chlorate present in both.

Ammonium chloride (0·01 *M*)	31
Pyruvic oxime (0·01 *M*)	0

(*C*) Perfusion of fresh soil. Percentage nitrogen appearing as nitrite in four days. 0·001 *M* potassium chlorate present in each.

Methionine (0·01 *M*)	5
Methionine (0·01 *M*) and pyruvic oxime (0·01 *M*)	69
Pyruvic oxime (0·01 *M*)	69

These results point to the conclusion that soils contain organisms, presumably heterotrophic, that can bring about a speedy oxidation of pyruvic oxime to nitrite. Oxalacetic oxime will also undergo nitrification, but no other oxime yet studied has been found to have this property. Oximes of acetone, formaldehyde, acetoacetic ester and benzoin have been tested and found to be inert. Moreover, they do not inhibit the nitrification of pyruvic oxime. The only substances yet found to inhibit the nitrification of pyruvic oxime in soil are sodium azide and sodium cyanide, both vigorous respiratory poisons.

Work, in collaboration with Dr. J. W. Stevenson, of the Bacteriology Department, McGill University, is in progress and has now resulted in the isolation of the organisms responsible from the enriched soils.

Whether or not pyruvic oxime is an intermediate in nitrogen metabolism of soil bacteria is a matter for further investigation. It is clear, however, that the presence in soil of a group of organisms that can rapidly nitrify pyruvic oxime without the intervention of the autotroph *Nitrosomonas* points to the possibility that the process of nitrification in soil may not be wholly accomplished by the autotrophic organisms and that the intervention of heterotrophs bringing about a direct nitrification of organic nitrogen compounds may take place.

[1] Lees, H., and Quastel, J. H., *Chem. and Indust.*, **26**, 238 (1944) ; *Biochem. J.*, **40**, 803 (1946).
[2] Audus, L. J., *Nature*, **158**, 419 (1946).
[3] Meyerhof, O., *Pflüg. Arch. ges. Physiol.*, **164**, 253 (1916) ; **165**, 229 (1916) ; **166**, 240 (1917).
[4] Lees, H., and Quastel, J. H., *Nature*, **155**, 276 (1945).

INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

ON the invitation of the British Government, the International Council for the Exploration of the Sea (Conseil Permanent International pour l'Exploration de la Mer) arranged to hold its thirty-seventh annual meeting in Edinburgh during October 3–11. The occasion was the more welcome since it was the first on which the Council had met in Scotland, while it is twenty years since it last met in Great Britain (London) in October 1929. Arrangements for the meeting were made by the Scottish Home Department.

The Council met under the presidency of Dr. K. A. Andersson of Sweden, who was re-elected president for the year 1949–50. Government delegates and experts from Iceland, Norway, Sweden, Denmark, Finland, Holland, Belgium, France, Spain, Portugal, Eire and the United Kingdom were present, and were very glad to welcome observers from the United Nations Food and Agriculture Organisation, from the United States and from Australia, together with visitors from various marine laboratories. It was regretted that representatives from Poland were unable to be present. H.M.S. *Cygnet* and H.M.S. *Welcome* (Fishery Protection Flotilla) visited the port of Leith for this occasion, as well as research vessels from Sweden, Belgium, France, England and Scotland, all of which were on view during the meeting.

The members of the Council and visitors were welcomed by the Lord Provost of Edinburgh, Sir Andrew Murray, and the joint Parliamentary Under-Secretary of State for Scotland, Mr. J. J. Robertson, when the Council held its first meeting in the City Chambers on October 3. Reference was made at this meeting to the loss sustained by the Council in the death during 1949 of Prof. Martin Knudsen of Copenhagen. Subsequent meetings of the Council were held in the Department of Zoology on the invitation of the University of Edinburgh.

Special arrangements were made to precede the meetings of the Council by a conference of herring experts from the various interested countries. This was held in St. Andrew's House, Edinburgh, during September 29–October 1 and was followed by a special 'herring meeting' of the Council on October 4, when the chief item was an address by Prof. A. C. Hardy (Oxford), who reviewed the whole field of herring research and made stimulating proposals for its development.

During the conference of herring experts, the various countries reported on their work since the previous meeting held in Aberdeen in 1946, and great interest was shown in the preliminary recaptures which have been obtained by Sweden, Denmark and Scotland following new methods of herring tagging. Previous attempts to label herring with external tags have been unsuccessful, so that future recaptures of such herring promise to provide greatly needed information about their migrations, growth, etc. A recommendation was passed that every effort should be made by all countries concerned with herring fisheries to undertake further tagging experiments, and in particular to compare the efficiency of the different types of tags in order to select those most likely to give a high percentage of recaptures.

Much interest was shown also in the preliminary results of applying the American and Canadian

methods of internal tagging to the herring fisheries of Norway and Iceland (where the greater use of fish-processing plants makes such methods possible), particularly in view of the growing evidence of large-scale seasonal migrations between north Iceland and Norway. Special arrangements were recommended for securing further information on the occurrence of these herring shoals with the help of all vessels of the member countries which operate in these northern waters.

Among other aspects of herring research, developments in the use of echometers were discussed, while several papers were read on the influence of the fishing on the herring stocks. Here the absence of really adequate statistics was felt, and particularly in view of the meeting of the Food and Agriculture Organisation at The Hague in August 1949, it was recommended that all countries take steps to provide standardized statistics of unit catches, so that an adequate watch can be kept on the signs of stock changes in the various fisheries and their possible causes. It was felt by all the representatives that so valuable have been the two herring meetings, and so great is the need for the closest international collaboration, that the various herring experts should now have regular opportunities to meet. All the area committees concerned with herring problems endorsed this feeling, and the Council agreed to establish a herring committee forthwith.

The scientific proceedings closed with another special meeting to review research problems in the fields of the commercial fisheries for Crustacea and Mollusca. A large number of interesting papers were circulated and discussed, and it was decided to adjourn the meeting until the next session of the Council at Copenhagen in 1950, so that progress and problems could be further discussed.

Apart from *ad hoc* meetings such as these, the greater part of the work of the Council is done by the standing committees dealing with research in the various regions and in certain special fields of study. During these meetings the progress of European fisheries research during 1948–49 was reviewed, programmes for 1950 were discussed and arrangements made for their co-ordination where necessary. In particular, the preliminary results of the international hydrographical-biological surveys of 1948 and 1949 were discussed, and arrangements made for a combined long-term fisheries research programme for the North Sea and the waters to the north-west and north-east. The arrangements for publishing the long-established *Bulletins Hydrographiques* and the much more recent *Annales Biologiques* were also reviewed, as were the arrangements for collecting, standardizing and publishing statistics of the various fisheries (*Bulletins Statistiques*) in which the advice and experience of the Fisheries Division of the Food and Agriculture Organisation were welcomed. The special international programme of salmon tagging was extended for another three years, and a co-ordinated investigation of salmon migrations around the Irish coast was recommended.

Great interest was shown during the meeting of the Southern North Sea Committee in Dr. Å. V. Tåning's account of the large-scale experimental transplantation by the Danish Government of plaice to the Dogger Bank area. So far, one million plaice have been transplanted, and the results of this major experiment will be awaited eagerly by all marine workers who are aware of the earlier experiments in this field.

The following committee chairmen were elected for the year 1949–50: *Consultative*, Dr. R. S. Clark; *North-Eastern Area*, Mr. G. Rollefsen; *North-Western Area*, Dr. Å. Vedel Tåning; *Atlantic*, Prof. Jean Le Gall; *Northern North Sea*, Dr. C. E. Lucas; *Southern North Sea*, Mr. R. S. Wimpenny; *Transition Area*, Dr. E. M. Poulsen; *Baltic Area*, Dr. Chr. Hessle; *Hydrographical*, Mr. Helge Thomsen; *Plankton*, Mr. F. S. Russell; *Statistical*, Dr. Nils Rosen; *Salmon and Trout*, Prof. K. Dahl; *Whaling*, Dr. N. A. Mackintosh; *Herring*, Dr. W. C. Hodgson; *Finance*, Dr. K. A. Andersson.

During the course of the discussion, various social gatherings were arranged, together with excursions, including a visit to the laboratory of the Scottish Marine Biological Association at Millport. Following the meeting, a number of the Continental delegates and experts took the opportunity to attend the joint meeting of the Challenger Society for the Promotion of the Study of Oceanography, on the invitation of the Society and the Marine Laboratory of the Scottish Home Department, Aberdeen.

AQUATIC LOCOMOTION

THE possibility that some aquatic animals may possess a propulsive mechanism of greater efficiency than that of a torpedo or submarine was the subject of a stimulating discussion at a joint meeting of Sections D (Zoology) and G (Engineering) at the Newcastle meeting of the British Association.

Prof. L. C. Burrill first described the distribution of velocity and pressure around a smooth streamlined body such as a fish or a submarine, deeply immersed in a fluid and advancing with uniform velocity. In such circumstances there is a positive or increased pressure on the forward part of the body which tends to retard the motion, and a similar increased pressure on the aftermost parts tending to assist the motion. On the middle part of the length there is a region of decreased pressure; but, owing to the shape, the fore and aft components here are small. In an ideal fluid, the net fore and aft component of the pressures and sub-pressures would be zero; but in an actual fluid such as water, when viscosity is present, there may be a small positive resistance retarding the motion, known as the pressure resistance. This is, however, usually very small when compared with the resistance caused by the rubbing of the fluid against the surface of the body, which is known as the skin-frictional resistance.

Prof. Burrill then proceeded to discuss the mechanism of this frictional resistance. He described the existence of a layer of fluid close to the surface of the body within which the forward velocity of the entrained fluid diminishes, rapidly at first and then more slowly, until a zone is reached where the forward velocity is very small. The thickness of this layer increases from forward to aft along the form. For low speeds of advance and short lengths of body, the flow within this boundary layer may be completely laminar, and successive layers of fluid appear to slide over each other smoothly and steadily. This type of flow may persist up to Reynolds numbers (VL/ν, where V is velocity, L is length of body and ν is kinematic viscosity (viscosity/density)) of about 5×10^6. For greater speeds and longer lengths of surface, the flow within the boundary layer is usually laminar for only a short length at the forward end.

This is followed by a short region in which the fluid is in a state of transition from laminar to turbulent flow. Beyond this the flow within the boundary layer becomes almost entirely turbulent, apart from a very thin laminar film, or laminar sub-layer, immediately in contact with the surface.

The thickness of this laminar sub-layer diminishes along the length towards aft, and if the roughness of the surface is such that the peaks of local excrescences project through this film, then an additional effect is present, which may be termed roughness effect. In these circumstances, the particles of fluid are tripped by the peaks of the excrescences, and small eddies are formed. Complete turbulence may then exist within the boundary layer, and when this occurs the resistance is governed by considerations of kinetic energy rather than viscosity effects, and varies as the square of the speed. As the local velocity over a considerable length of the middle part of the form is increased relative to the general stream velocity, and only for short lengths at the forward and after ends is the local velocity below the speed of advance, the mean velocity of rubbing is slightly greater than the velocity of advance. The frictional resistance is therefore slightly greater than that of a flat surface of the same length and area travelling at the same speed. This effect, which may amount to about ten per cent in some instances, is known as the form effect on frictional resistance.

Outside the boundary layer, the fluid is in streamline flow, and the pressure and suctions are transmitted through the fluid in the usual manner for potential flow. The point in the length at which laminar flow ceases is dependent mainly on the local Reynolds number, measured by Vl/ν, where l is the length from the entrance. Towards the after end of the form, a position may be reached where the fluid particles have been slowed down to such an extent within the boundary layer that there is not sufficient kinetic energy to carry the boundary layer through to the zone of increasing pressure at the tail end, and in these circumstances reversal of the flow may occur, resulting in separation and serious losses due to eddy shedding.

An application of the principles described by Prof. Burrill to the movement of fish was then made by Dr. E. G. Richardson and Mr. G. E. Gadd. Dr. Richardson described some model experiments designed to throw light on the resistance of fishes in motion. The first set of experiments was intended to show that there is nothing in the nature of the shape or bodily covering (scales and mucus) of a fish which could give it when 'coasting' a less resistance than that of a wooden model of the same form. This was shown by comparing in a tank the rates of fall of dead fish, loaded with weights, and wooden models made accurately to the same shape. No difference in the trajectories of animal and wooden model could be detected.

After a study of the theory of the method of propulsion adopted by the majority of aquatic animals, that is, sinusoidal motion of the whole or a portion of the body, this was also studied on a model scale, using a flexible 'flag' hanging vertically in a small wind tunnel and agitated in periodic oscillation at its upper end. As the model fish was attached to a force balance at the nose, it was possible to measure the propulsive force derived from different frequencies and amplitudes of oscillation against a current the value of which could also be varied through the speed control of the tunnel. Results showed how the resistance or propulsive force varied with the speed of waves along the body, relative to the speed of the stream. The 'resistance' of a fish can be referred to in terms of these two speeds, in the same way that the 'resistance' of a screw propeller is a function of revolutions and speed of advance.

Mr. Gadd dealt with certain hydrodynamic aspects of the swimming of fish. A steadily swimming fish transmits a wave of increasing amplitude backwards along its body at a speed greater than the forward speed of the fish. Usually the tail moves much more than the rest of the body, but one can imagine for convenience a fish in which the body wave is of constant amplitude. It might be supposed that such a fish would experience much the same thrust as would occur for a rigid body, bent into the wave form, and pushed backwards at the speed at which the wave moves through the water. This, however, may be untrue because not only does the fish differ in its motion from the rigid body at the ends, but also the movement of the surface of the fish relative to the water differs from that of the surface of the rigid body.

This latter difference may be important because it may affect what is known as 'flow separation'. Separation is said to occur when the flow past a body does not conform smoothly to its shape but forms an eddying region behind it. Its occurrence can be greatly affected by surface conditions. Hence, although the rigid body pushed backwards would experience separation from its forward inclined surfaces (and over areas from which separation occurred the pressure would be reduced, producing a forward thrust), it is not certain that separation in general occurs over the body of a fish. In the particular case of fishes like the eel, which have long, continuous anal and dorsal fins, some separation must occur, since the flow could not otherwise negotiate the sharp edges of the fins. Hence with these fish the propulsive thrust is probably primarily the result of separations from the forward inclined surfaces.

In general, however, separation does not necessarily occur. In attempting to analyse what would happen if it did not, one may consider the simple case of a slender pointed-ended body without fins executing small-amplitude fish-type motions the amplitude of which is greatest at the rear. One finds that no net thrust occurs: there is a propulsive force associated with lateral accelerations of segments of the body which is balanced by a drag associated with the rearward tapering. Accordingly, if a small tail fin were fitted to this body—when it would somewhat resemble a mackerel, the body of which is pointed at the rear—most of the propulsive thrust would come from the fin, acting like the wing of a bird. Hence, if no separation occurs with a mackerel, most of its thrust probably comes from its fins (but note that the small sawtooth fins over top and bottom of the body at the rear may cause separations). If the body considered above, instead of being pointed at the rear, were flattened laterally and fitted with a tail fin, so that it somewhat resembles a 'typical' fish, some thrust would probably come from the body as the drag forces arising from the rearward tapering would probably be reduced. Hence 'typical' fish probably obtain thrust from their bodies as well as their fins, whether separation occurs or not.

The present state of knowledge concerning the speed and available horse-power of a variety of aquatic animals was reviewed by Prof. J. Gray, who stressed the urgent necessity for more extensive and

trustworthy information concerning the maximum speed of fish of known size. The behaviour of fish, as observed photographically in the laboratory, suggests that a trout 20 cm. long can only sustain a speed of 5 miles per hour for a relatively few seconds. On the other hand, the powers of acceleration of the animal are remarkably high—starting from rest, the fish may attain their maximum speeds in a fraction of a second. A sustained speed of five m.p.h. agrees with what is known concerning the available horse-power of the muscles and the resistance of the body of the animal as determined by Dr. Richardson. In the case of the dolphin, however, the speed of the animal appears very greatly to exceed that calculated from a reasonable estimate of muscular horse-power.

No final conclusions can be derived from this discussion; but the British Association is to be congratulated on a very successful attempt to concentrate attention on what is a very interesting, and possibly important, border-line subject.

OBITUARIES

Prof. Alfred S. Barnes

THE death on November 11 of Alfred S. Barnes removes another survivor of a former generation of the teachers of the Manchester Municipal School of Technology: most have passed away. The School—then the largest and best equipped in Great Britain—was opened in 1902; Barnes was appointed in 1901 as professor and head of the Department of Physics and Electrical Engineering. There were seven other professors, of whom F. Jackson Pope (afterwards knighted) and J. T. Nicholson may be specially mentioned. Though Barnes had not the scientific equipment of these two, his industrial experience, his acumen and regard for precision made him a good organiser. The Department developed; the number of students taking the evening part-time courses increased, partly by the diversity of the subjects catered for. In those early days all the electrical subjects taught in the day department were required for the associateship diploma of the School.

Barnes believed in amplifying the teaching by external lecturers from the industry. William Cramp and Julius Frith (consulting engineers) strengthened the day teaching of electrical design. Of others, Miles Walker succeeded Barnes as professor, and A. P. M. Fleming (now Sir Arthur Fleming) lectured on insulation.

In 1905, the day school became the Faculty of Technology of the University of Manchester, and Barnes was elected to the chair of electrical engineering. He was a good speaker and a power in the Faculty and in the Senate. He was of imposing presence, had clear-cut features, and on account of his hair brushed well back was affectionately called by his students "'Airy Alf".

In his desire for precision he encouraged the late A. E. Moore to develop a standardizing laboratory, which was the best equipped outside the National Physical Laboratory. Barnes gave the present writer charge of a high-tension laboratory; thus was started the first 'School' in the country for high-tension technics (later high-voltage engineering).

Barnes's researches were of a practical kind. A joint paper on "Fuses" read at the Institution of Electrical Engineers was awarded a premium. Travelling by train from his Buxton home, he observed corrugations on the rails. Investigating the causes of their formation, he submitted another paper to the Institution. Near Buxton he discovered some flints which appeared to be worked by prehistoric man: further investigations led to a paper presented to the Manchester Literary and Philosophical Society. Even after he had retired, his interest in anthropology took him to many places, including France and Ceylon.

Barnes resigned his professorship in 1912 to become staff inspector at the Ministry of Education, retiring in 1928. He initiated the short courses for engineering teachers, organising them for many years. Even after his retirement he attended the Oxford Summer Course for Engineering Teachers, acting as chairman for about ten years. Barnes was largely responsible for the inception of National Certificates in Engineering. He was a religious man, and often would give talks on spiritual matters and the heritage of humanity to Brotherhoods in and around Manchester. Such were the facets of his life's work.

J. L. LANGTON

Mr. Willoughby P. Lowe

BY the death of Willoughby P. Lowe there passes one of the last of the professional collectors who worked so successfully on behalf of the British Museum.

Willoughby Prescott Lowe was the son of the Rev. Edward Lowe and was born at Tyler's Green, Buckinghamshire, on December 10, 1872. From his childhood he was interested in natural history, and at the age of sixteen went to Colorado to join his brother on a sheep-run. There he remained for nine years and had ample opportunity for engaging in his favourite pursuit. In 1897 he returned to England and ten years later went to the Philippines on behalf of the British Museum to collect birds and mammals. Thereafter he became a professional collector and undertook some seventeen collecting expeditions, on behalf of the British and other museums, to many parts of the world. Most of his collecting, however, was done in Africa, and it is safe to say that he contributed more specimens from that continent to the British Museum collections than any other collector. He accompanied Abel Chapman and Admiral Lynes to the Sudan, and later spent two years with Lynes collecting in the Darfur Province of the Sudan. He also went with him to Tanganyika in search of Cisticolas.

By special arrangement Lowe was able, on two separate occasions, to visit the west coast of Africa on H.M. gunboats, and at different times he made expeditions to the Gold Coast, Gambia and French Guinea. In company with Dr. David Bannerman he made an important collection in Tunisia and, some years later, in January 1931, went as assistant to Colonel Meinertzhagen on a trip to the Haggar Mountains in the Sahara. Lowe took part in the Anglo-American expedition to Madagascar and on four different occasions made collecting trips to Indo-China with M. Jean Delacour. In 1922 he published an interesting account of his earlier expeditions entitled "The Trail which is Always New", and five years later "The End of the Trail", in which he completed the story of his collecting life.

Lowe's quiet and unassuming nature endeared him to his friends, and as a travelling companion he was always helpful and completely unselfish. After he retired from active collecting he worked for a number of years as honorary curator of the Royal Albert

Museum, Exeter, and did excellent work in arranging the bird and mammal collections in that institute. Early in the War he met with an accident in the black-out which seriously injured one eye, and later he became almost totally blind. To a man of such active habits this was a terrible blow; but he bore it with great fortitude. On October 3 he died after an operation, at the age of seventy-six. In 1895 he married Annie, daughter of Captain John Seals, who survives him together with a son and a daughter.

N. B. KINNEAR

WE regret to announce the following deaths:

Mr. W. E. Copleston, C.S.I., formerly chief conservator of forests, Bombay, on December 1.

Prof. René Mairo, professor of botany in the University of Algiers, one of the twelve non-resident members of the Paris Academy of Sciences, on November 24, aged seventy-one.

Dr. Henry C. Williamson, formerly of the Fishery Board of Scotland, on December 9, aged seventy-eight.

NEWS and VIEWS

Geological Society: Awards for 1949

THE Council of the Geological Society has announced the following awards: *Wollaston Medal* to Dr. Norman L. Bowen, of the Geophysical Laboratory, Washington, in recognition of his eminent researches in quantitative experimental petrology and for his brilliant application of these and related studies in the elucidation of fundamental problems of petrogenesis. *Murchison Medal* to Mr. Tom Eastwood, lately assistant director of H.M. Geological Survey, for his long and distinguished work on the Geological Survey, especially in the realm of economic geology. *Lyell Medal* to Prof. S. J. Shand, for his outstanding contributions to the advancement of geology, embodied especially in his book on "Eruptive Rocks" and numerous published papers on the petrology of the felspathoidal rocks of South Africa, Canada and Scotland. *Wollaston Donation Fund* to Mr. G. A. Kellaway, in recognition of his work on the stratigraphy and structure of the Northamptonshire ironstone district and the Bristol–Somerset Coalfield. *Murchison Geological Fund* to Dr. H. Dighton Thomas for his researches in fossil corals, sponges and other invertebrates. A moiety of the *Lyell Geological Fund* to Dr. J. E. Hemingway for his studies of the stratigraphy, structure and sedimentary petrography of the Jurassic rocks of North-East Yorkshire; another moiety of the *Lyell Geological Fund* to Mr. J. Selwyn Turner for his contributions to Carboniferous stratigraphy and structural geology.

Food and Agriculture Organisation: Statistics Officer in the Far East

THE Economics and Statistics Division of the United Nations Food and Agriculture Organisation has appointed Mr. C. P. G. J. Smit to be regional representative for statistics in Asia and the Far East. Mr. Smit, who has been with the Netherlands Government for twenty-one years, was formerly deputy director-general of statistics at the Central Office of Statistics, The Hague, and was responsible for all statistical work done in that Office, including work with agricultural statistics. He has also acted as chairman of the Standing Advisory Committee on Statistics of the Food and Agriculture Organisation since that Committee was set up in 1946. In his new appointment Mr. Smit will work at the Organisation's Central Office of Statistics in Bangkok, and there he will work with Governments of the region, assisting them on statistics problems, especially with regard to the 1950 world census of agriculture. He will also be responsible for some of the statistical work needed for the International Rice Commission.

Joseph von Mering (1849–1908)

JOSEPH FRIEDRICH FREIHERR VON MERING, who was born in Cologne a century ago on December 28, is remembered as a pioneer in the work on diabetes; his paper, with Oscar Minkowski, in the *Archiv für experimentelle Pathologie und Pharmakologie* (**26**, 371; 1890), reported the production of diabetes in a dog following extirpation of the pancreas. Four years previously, von Mering had produced experimental diabetes by means of phloridzin, and his interest in this condition was probably derived from his teacher, Kussmaul, who introduced the term 'acetonæmia' in diabetic coma, later named 'acidosis' by Naunyn. After obtaining his M.D. at Strassburg in 1874, von Mering became assistant to Richard von Krafft-Ebing and to Friedrich Jolly. Having worked with von Frerichs, Kussmaul and Hoppe-Seyler, he was appointed professor of medicine and laryngology at Halle in 1890, and in 1900 director of the Medizinische Klinik. Von Mering synthesized veronal, and his "Lehrbuch der Inneren Medizin" (1901) went through four editions before his death on January 5, 1908. A true aristocrat, approachable and kindly, vivacious, impulsive and quick-tempered, von Mering was eminently practical in his scientific outlook; for theories and hypotheses he had neither time nor talent.

Defence Services Research Facilities Committee of the Royal Society

IN many fields of scientific work the Defence Services in Great Britain possess equipment, knowledge and personnel which, if available, might be used for helping scientific researches unconnected with any Service objective. In some cases facilities of this kind have been provided for several years. In 1948 the Defence Services Research Facilities Committee was set up by the Royal Society not, as some have supposed, to offer scientific help to the Services, but to enlist the help of the Services on behalf of scientific workers. The terms of reference of the Committee are: "To consider proposals for the use of Service facilities and personnel for assisting scientific research, and to make recommendations to the Council of the Royal Society, the Lords Commissioners of the Admiralty, the Army Council, the Air Council and the Minister of Supply". To give an idea of the facilities which the Committee hoped would be available, the subjects dealt with by the five panels which were established to consider applications for help are as follows: (*A*) submarine gravity measurements, (*B*) surplus explosives, (*C*) magnetic survey, (*D*) aerial photography, (*E*) scientific expeditions.

The Defence Services have been most co-operative; the following examples illustrate the scope of the

help which they have already given. The Admiralty provided a submarine on two occasions for gravity observations at sea, and lent a kite balloon and personnel for research on the feeding habits of swifts. The War Office lent equipment to a geological expedition to Spitsbergen. The Air Ministry provided: a helicopter fitted with a large net for collecting insects, photographic cover for an archæological expedition to Tripolitania, flying-boats of Coastal Command for two flights to observe the breeding grounds of seals and sea-birds, six cameras to the International Committee for Bird Preservation for use in a wildfowl census, and a considerable number of aerial photographs of specific areas required by men of science from time to time; in addition, arrangements were made for the Royal Air Force to fly photographic plates at high altitudes in connexion with cosmic-ray research. In another instance, the co-operation of the Ministry of Supply was obtained in the development of an airborne magnetometer. Men of science wishing to submit proposals for consideration by the Committee should communicate their suggestions to the Assistant Secretary of the Royal Society, Burlington House, London, W.1.

25-Inch Telescope Disk for the University of Michigan

A LARGE telescope disk for the University of Michigan has just been completed by Chance Brothers, Ltd., of Smethwick, Birmingham. Now that work is finished on the moulding and annealing of the disk, which is of dense flint optical glass, 25 inches in diameter and almost 4 inches at its thickest edge, it will be dispatched to the Perkin Elmer Corporation in the United States, where it will be ground and polished for use in the objective of a new Schmidt-type telescope now being built for the University of Michigan by the Warner Swasey Co. of Cleveland, Ohio. The sequence of operations necessary for the production of this disk occupied eight months. A special melting of glass of the required composition to give the necessary refractive index was rendered homogeneous by stirring and then cast into a large block weighing about half a ton. The surfaces of the block were polished to detect any portions containing defects. Finally, a portion weighing about 250 lb. (approximately a quarter) was selected, heated to softening point and moulded to the required circular shape. The surfaces of the moulded disk were then polished for further inspection; after which it was annealed in an electric furnace, this operation taking four weeks. Finally, the disk was tested in the Chance Laboratories, first on an interferometer to prove the perfection of optical homogeneity, and, finally, in polarized light to detect any abnormal mechanical stresses which might affect its performance. A second disk, similar to the one described, is also being manufactured for the Warner Swasey Co. It is of interest to note that Messrs. Chance Brothers are now celebrating the hundred and twenty-fifth anniversary of their foundation.

Exhibition of Physics Instruments in Paris

THE annual exhibitions of scientific instruments held in London by the Physical Society are well known, and the printed catalogues of these exhibitions, containing as they do a wealth of information which is handy for reference and not easily accessible in any other form, have proved most useful to many research workers and institutions, even many years after the particular exhibitions of which they form a record. The annual exhibitions of scientific instruments and materials of the Société Française de Physique deserve to be equally well known. The 1949 exhibition was held at the Sorbonne (University of Paris) during June 4–9, and for the first time a detailed printed and illustrated catalogue of the exhibits was issued. To those who were unable to visit the exhibition this catalogue should prove valuable as an introduction and guide to the resources and state of development of the research institutions and instrument manufacturers in France. Of the 200 pages of the catalogue, 137 are devoted to descriptions of the apparatus exhibited by the eighty-five different exhibitors, and forty to advertisements. As is explained by P. Jacquinot, general-secretary of the Société, in the introduction to the catalogue, the usual troubles in compiling the catalogue were experienced, and the descriptions given of the various pieces of apparatus vary in length from just a brief title, which conveys almost nothing to the reader, to detailed technical expositions of construction and method of use. However, even a brief glance through the pages of the catalogue is sufficient to assure the reader of the diversity and high standard of the apparatus exhibited. Further, the excellent alphabetical indexes with which the catalogue is provided afford easy reference to any piece of apparatus or to its manufacturer.

Air Transport and Insects of Agricultural Importance

CONSIDERABLE attention has been given in recent years to the risk of spreading disease-carrying insects by the agency of air transport. Almost no consideration has been given to the possible introduction of new agricultural pests by the same means, although the development of new routes and the short time taken to traverse great distances are unquestionably adding greatly to the risk of such invasions. The Commonwealth Institute of Entomology has recently published a small pamphlet (pp. 12, price 1*s.* 6*d.*) on this subject by Dr. W. A. L. David. Up to the present time, although many disastrous introductions have occurred both in Europe and in the United States within the past fifty years, there has been no authenticated case of air transport having been responsible. But insects of many kinds are found surviving in aircraft, and the danger will increase. Tolerably efficient methods of freeing aircraft of flies and mosquitoes are being worked out; but these are certainly not lethal to more resistant insects—even when they are properly applied. Perhaps the deposition of a lasting film of insecticide is the most promising line of development. Some modifications in the planning of the interior of aircraft could reduce the number of lurking places for insects and thereby make disinfestation easier.

Flightless Birds of New Zealand

IN Dominion Bulletin, No. 15, Mr. W. R. B. Oliver has summed up the available information concerning that remarkable group of flightless birds, the moas, some of great size, that formerly inhabited New Zealand and parts of Australia, but have all vanished, being only known to us through their remains. It appears that the birds, unable to fly, were liable to get engulfed in bogs, in which marshes their bones have been preserved, often in surprising numbers. It is to such remains that we owe our knowledge, though the birds must have survived up to comparatively recent times, because Maori camp

sites have yielded charred and broken bones. Mr. Oliver sums up the reasons for the disappearance of what was once a considerable population, embracing many species of these specialized birds, in these words: "Man has been a great exterminator of species in all parts of the world; and so it seems with great probability that in New Zealand man contributed most to the disappearance of the moa. . . . We know by numerous finds that man killed the moa for food and collected its eggs for the same purpose and for making utensils for water. . . . The fact that the moa disappeared when man arrived points very strongly to these events being related, so whatever the causes for the decrease of the moa population during the Pleistocene period its final extinction was due to man."

Population Distribution in England and Wales

THE Registrar General for England and Wales has recently issued a booklet entitled "Estimates of the Sex and Age Distribution of the Civilian Population in Regions and Administrative Areas of England and Wales at 31st December, 1947" (London: H.M. Stationery Office, 2*s.* 6*d.*). This publication fills a gap which has been felt by all those who have had to work on local populations. Great changes have taken place in the distribution of the population and its age-composition since the last national census in 1931; the National Register of 1939 is also out of date and was taken at a time when evacuation and call-up distorted the picture. The present estimates are based on the maintenance files of local national registration offices, and the figures have been adjusted in the General Register Office. The civilian population only is covered; conscripts away on national service are therefore excluded, as are members of the mercantile marine. The omission of conscripts, who are away only for relatively short periods, is unfortunate, and it would have been desirable if an estimate of their numbers in different regions and localities could have been given. Figures are available for all local government areas down to district-level, and for the geographical regions of the General Register Office, as well as for the standard regions generally adopted for regional organisation by government departments. There are twelve age-groups for males and fourteen for females. It is to be hoped that a similar publication for Scotland will be issued, so that the whole of Great Britain will be covered. It is satisfactory to see that the much decried system of national registration can yield this valuable statistical by-product.

International Colloquium on Rheology in Biology

AN international colloquium on biological topics that involve problems in rheology has been arranged to take place in Scandinavia during July 1950. It will last for approximately four days, during the interval between the International Congress of Botany (Stockholm, July) and the International Congress of Physiology (Copenhagen, August). The colloquium will include papers and addresses by workers in such fields as the circulation of blood, the mechanical properties of muscle, the movements of sap in plants and the rheological behaviour of protoplasm. It has been arranged under the auspices of the Joint Committee on Rheology of the International Council of Scientific Unions, by an organising sub-committee consisting of Prof. H. Eyring (Utah), Prof. A. Frey-Wyssling (Zurich), Prof. G. van Iterson (Delft) and Dr. P. Eggleton (Edinburgh). Further details can be obtained from Dr. P. Eggleton, Department of Physiology, University, Edinburgh.

Course on Forestry in Scotland

A COURSE on forestry in Scotland will be held during September 11–23, 1950, under the auspices of the British Council and arranged by the Forestry Department of the University of Aberdeen, in conjunction with the Forestry Commission. This course is intended for staffs of State forest services and of academic and research institutions in Commonwealth and foreign countries; the number of participants will be limited to twenty, and they must be proficient in English. Topics on the course will include the research which is being conducted at the University of Aberdeen on Scots pine (*Pinus silvestris*) and the so-called Scottish race of European larch (*Larix decidua*). The re-afforestation work of the Forestry Commission and the working of the Government scheme for the dedication of British woodlands will also be considered. Altogether four days will be spent in the University of Aberdeen and nine days on a tour through north and central Scotland. The estimated total cost, including return fare from London, will be £28 per person. Accommodation will be reserved in hotels. Further information, including method of application, can be obtained from the Area Officer, British Council, 22 Bridge Street, Aberdeen.

Institute of Biology: First General Meeting

THE first general meeting of the newly proposed Institute of Biology (*Nature*, 164, 776; 1949) will be held in the Great Hall, King's College, Strand, London, W.C.2, on January 5, at 6 p.m. The meeting is open to all biologists interested in the founding of this Institute.

The following have consented to serve on the first Council of the Institute: Dr. E. Hindle, F.R.S., Prof. T. A. Bennet-Clark, Prof. G. E. Blackman, Mr. L. J. F. Brimble, Prof. J. F. Danielli, Dr. D. G. Davey, Captain C. Diver, Dr. J. W. Evans, Prof. A. Graham, Prof. J. Gray, F.R.S., Prof. A. Haddow, Dr. J. Hammond, sen., F.R.S., Dr. C. Horton-Smith, Prof. W. H. Pearsall, F.R.S., Mr. N. W. Pirie, F.R.S., and Wing-Commander F. S. Russell, F.R.S.

Paper for Periodicals

REPLYING to a question in the House of Commons on December 15, Mr. H. Wilson, president of the Board of Trade, stated that from March 1, 1950, existing magazines and periodicals would no longer be limited for their home sales to a percentage of their pre-war consumption of paper, but would be allowed to use all the paper they could obtain. The restrictions on new publications would also be withdrawn.

Announcements

THE Faraday Lecture for 1949–50 of the Institution of Electrical Engineers will be given by Dr. R. A. Smith at the Central Hall, Westminster, London, S.W.1, on January 18, the subject being "Radar".

THE Council of the Royal Society has made a grant of £1,000 towards the establishment of a Great Barrier Reef Marine Biological Station, probably on Heron Island. This grant is being made from a fund left to the Society by the late E. T. Browne to aid marine expeditions and marine biological research.

LIPOPROTEINS

A DISCUSSION on lipoproteins, organised by the Colloid and Biophysics Committee of the Faraday Society, was held in the Department of Pharmacology of the Medical School of the University of Birmingham during August 29–31, 1949. Prof. E. K. Rideal, who was in the chair at the opening meeting, said that this Committee, which has been in existence for a good many years, was originally due to the initiative of Sir William Hardy, and was intended to provide a bridge between the simpler systems with which colloid chemistry was then mostly concerned and the properties of living matter.

However tenuous the bridge may have been in earlier days, it is now a robust structure which carries a good deal of traffic in both directions. The Faraday Society has recognized the coming-of-age of this approach to living systems by revising the terms of reference of the Committee so that it now covers biophysics as well as the applications of physical chemistry to biology. The Committee consists of three representatives of the Faraday Society, with a number of representatives of other biological, chemical and physical societies having an interest in this field. During the past twenty years the old Colloid Committee had been responsible for one discussion meeting every two years on various topics usually having a biophysical flavour. The new Committee, however, will now have the responsibility of organising a discussion every year, the present one on lipoproteins being the first. In addition, informal half-day meetings on special topics, such as the one recently organised by Dr. R. K. Schofield at Rothamsted, are being arranged.

The meeting on lipoproteins fell into three parts. The first was concerned with the nature of the interaction between proteins on one hand and fatty acids and similar compounds on the other. A number of techniques were described which are used to investigate these interactions. Dr. J. H. Schulman and Drs. P. Doty and R. Matalon described monolayer techniques of investigating the interaction of proteins with fatty acid monolayers. Prof. Murray Luck described the investigation of the binding of fatty acid anions by measurements of the equilibrium between the inside and outside of a dialysis bag containing the protein. It is interesting to find that serum albumin, which probably functions as a lipid transporter, is in a class by itself in its combining capacity for fatty acid anions and is able to bind about twenty-five ions per molecule. Dr. K. G. A. Pankhurst has investigated the interaction of gelatine with detergent ions, and finds that the penetrability of gelatine depends on the cross-section of the anion. Prof. D. G. Dervichian discussed the nature of protein-lipid interaction.

Discussion on these topics revealed a considerable divergence of views on the nature of the combination. Are protein-lipid complexes stoichiometrical compounds; or micelles of fat covered with a layer of protein; or protein molecules surrounded by layers of lipid? What are the forces uniting the fatty acid anion with the protein? The main conclusion from the discussion seemed to be that proteins vary greatly in their reaction with lipids. The synthetic protein–fat mixtures do not necessarily give any very close clues to the nature of the natural protein–lipid complexes, in which the protein may be specially adapted to its function of combining with lipids.

The second part of the discussion was concerned with the natural fat-protein complexes of blood. Prof. D. Macheboeuf and Dr. P. Rebeyrotte described their work on a lipoprotein obtained by acid precipitation of horse serum. Dr. A. S. McFarlane discussed ultracentrifugal and electrophoretic experiments on the state of lipids in blood plasma. Drs. G. Popják and E. F. McCarthy described measurements which show that the lipids present do not contribute to the osmotic pressure of serum. Miss Mary Pangbourne discussed the difficult problems of the role of lipids in serology and in immunological reactions. Prof. A. C. Frazer gave an account of his work on the absorption of fats. His view is that fat digestion in the intestine is very incomplete, and that neutral fat is absorbed as such in the form of minute emulsified particles of size less than $0{\cdot}5\,\mu$ in diameter, which can be detected in the blood under dark-ground illumination. These are absorbed via the lacteals, while the soluble fatty acid–bile acid complexes pass directly from the intestine into the portal blood.

Another approach to the question is provided by the work of the Physical Chemistry Laboratory of the Harvard Medical School on the fractionating of the blood proteins, which was described by Prof. E. J. Cohn and Dr. J. T. Edsall. This has resulted in the isolation and characterization of two quite distinct lipoproteins. The α-lipoprotein, which is associated with the albumin fractions, but is a fairly minor constituent of the serum, consists of about 65 per cent protein and 35 per cent lipid materials, and has a molecular weight of 200,000. The β-lipoprotein, which is associated with the globulins, accounts for three-quarters of the lipid of fasting human plasma. It is a very complex substance containing 25 per cent protein, 30 per cent phospholipid and 45 per cent of cholesterol. A spherical particle of molecular weight 1,300,000, it is obviously of great significance for the transport of fats in the blood.

The third part of the symposium was concerned with lipoproteins in cell structures. This became necessarily a review of isolated observations of separate phenomena, since so little is known. Prof. A. Claude gave a much appreciated lecture on his work on separating the cell particles of different sizes by means of differential centrifugation. The larger particles, the mitochondria, are usually about $2\,\mu$ long and $0{\cdot}4\,\mu$ in diameter, and therefore have a dry weight of $1{\cdot}4 \times 10^{-7}\,\gamma$, which corresponds to something of the order of 1,000,000 protein molecules. They contain 25 per cent of lipids and 8–10 per cent of ribonucleic acid. Since it has been found that the oxidizing enzyme systems of the cell are concentrated in these particles, they are probably very much concerned with the utilization of energy in the cell and the oxidation of fats. The smaller particles, the microsomes, which account for 50 per cent of the dry weight of the cell, have been found to contribute very little enzyme activity.

Prof. E. Chargaff discussed a number of types of lipoproteins taken from animals (for example, lipovitellin from the yolk of hens' eggs, and the thromboplastic protein of lungs) as well as those contained in the chloroplasts and chromoplasts of plants, which contain a very high content of lipids. Prof. A. Frey-Wyssling described his studies of chloroplasts, and Drs. J. Elkes and J. B. Finean gave an account of the changes of X-ray diffraction pattern caused by drying the sciatic nerve of frogs.

It was inevitable in a field which is at such an early stage of exploration that the subjects discussed lack coherence, but it was clear to everybody that large territories are awaiting exploration, and the work so far done barely scratches the surface. The whole discussion served to bring together those who have been working on these complex biological materials, with the physical chemists whose work has hitherto been largely confined to simple systems. It was apparent that the work done in isolating natural lipoproteins and fat-containing particles provides a practical starting point for investigations in which the precise methods of the latter are applied to substances of direct biological importance.

J. A. V. BUTLER

ACOUSTICS OF ROOMS

AT this critical period of post-war reconstruction, the problems of architectural design are rising with special acuteness, accentuated by new methods of building construction and limited material resources. One of the most pressing of these problems is the fulfilment of acoustic requirements in committee and lecture rooms, studios, theatres and concert halls. The importance of acoustic design is reflected in the increasing interest in acoustical research and in the growing demand for instruction in acoustics in the schools of architecture. The importance of the subject is equalled by its difficulty. It is the meeting-ground of art and mathematics, of psycho-physical and physical studies. Even on its objective side it is highly complex and resistant to analysis.

The Acoustics Group of the Physical Society is therefore to be congratulated for arranging the course of six lectures on room acoustics which were given in the Royal Institution by Dr. Richard H. Bolt, director of the Acoustics Laboratory of the Massachusetts Institute of Technology and president of the Acoustical Society of America. These lectures, supplemented by three colloquia, presented to British architects and acoustic engineers a summary of accepted theory, a report of recent progress, and a review of problems requiring further investigation.

The course opened with a discussion of the classical theory of W. C. Sabine and A. Jaeger. This theory was based on the assumption of uniform diffusion of sound energy in the room. It predicts an exactly exponential decay of sound energy with a definite value of reverberation time which is inversely proportional to the total sound absorption of the air boundaries. Using modern methods of sound recording, it is easily shown that the assumption of uniform diffusion is, in general, not in accordance with facts, for variations in sound-level are observed when a non-directional microphone is used at different points in the room or when a directional microphone is used in different orientations about a fixed point. The experimental decay curve usually shows fluctuations, and when these are smoothed out, the resulting curve is not strictly exponential, the rate of decay decreasing with time. Serious departures from theory may be observed when the reverberation method is used for measuring the absorption coefficients of acoustic absorbents, for even when diffraction effects are kept small, the measured values of absorption depend not only on the particular room used, but also on the position and orientation of the tested sample. Nevertheless, the conditions assumed by Sabine are the ideal conditions for room acoustics, and recent work has been directed towards discovering the means of attaining them.

A wave theory is required to give a complete account of the phenomena. The primitive conceptions are still simple. The air in the room has a large number of normal modes of vibration, each having a characteristic natural frequency. The wave equation is separable in the co-ordinate systems appropriate for a number of shapes of air space, and the corresponding normal mode solutions for rigid and for slightly absorbing walls are obtainable in a straightforward manner. When a steady source of sound is used, forced vibrations of the wave states take place, and transient free vibrations are excited by starting and stopping the sound. Photographs due to Knudsen[1] were displayed showing the transients excited by stopping a single-frequency source.

The wave theory for the case of a rectangular room with slightly absorbing walls was treated in some detail. Here the normal modes are a system of plane waves, and the natural frequencies can be represented by a lattice of points in the first octant of a three-dimensional frequency-space. The vectors representing the points have a magnitude proportional to the frequency and a direction parallel to the wave normal. The lattice is the basis of calculations of the number of normal modes of any type having frequencies between given limits[2]. The chief types are the oblique, tangential and axial modes, and these have characteristically different damping constants and energies per unit amplitude. The oblique waves have the greatest and the axial waves the least rates of decay. The shape of the smoothed reverberation-time curve is thus explained. It follows that, in such a rectangular room, strictly exponential decay cannot be obtained even for high-frequency sound.

The statistics of the eigen states of rectangular rooms were examined by Dr. Bolt in terms of fluctuation parameters, and the treatment was made more general by the use of non-dimensional frequency and room-shape variables. The smoothness of the frequency response was expressed by using ρ, the ratio of the actual spacing to the average spacing of the frequencies. The second moment of ρ gives a measure of smoothness. Diagrams were shown giving the relation between smoothness and room shape[3].

Up to the 'critical range' from the source, the energy density is predominantly due to direct radiation, and beyond this range the sound field is incoherent. The statistical properties of the incoherent field of a steady source have been studied by varying the frequency[4] or by varying the position of the microphone[2], and the results give respectively the 'transmission irregularity' and the 'space irregularity'. Satisfactory agreement has been obtained between theoretical and experimental values for the first of these parameters, and one or both of them may, in the future, prove to be convenient means of estimating the diffuseness of the sound field.

The course included a short account of the relation between the damping constants of the normal modes and the specific normal impedance of the walls, and also a discussion of the dependance of normal impedance on the porosity and flexibility of the wall. The theoretical energy losses at the wall expressed in terms of viscous and heat losses do not account for the total loss observed experimentally. In certain

cases there is evidence in the decay curves of the existence of non-linear contributions to the energy loss, and this has been substantiated by photographic examination of the fluid motion at round apertures. A series of smoke photographs was shown which established the presence of vorticity near an aperture. The effect was shown with sound-levels as low as 60 db. above 0·0002 dynes/cm.². It was seen to build up at greater sound-levels until at 120 db. regular shedding of vortices took place. In porous wall materials, the energy of rotation and translation of such vortices must contribute to the total energy loss. In the one case which has been fully examined, the total energy loss was exactly accounted for by including vorticity losses.

Such non-linear losses are an appreciable part of the total loss, and are, of course, a function of time as well as of amplitude. The situation envisaged in relation to pulsed sound is therefore that there must be a limit to the validity even of measured impedance values.

The theory of the perturbation of the normal modes by changes of boundary shape or of boundary impedance has been very successfully applied to determine the boundary conditions which produce a diffuse sound field. In effect, such perturbations, in the second order of approximation, result in the exchange of energy between different normal modes. For example, in the case of rectangular rooms, energy may be transferred from oblique to axial modes and *vice versa*, and when this takes place sufficiently freely, Sabine conditions are obtained. The probability of such transfer depends on the value of the surface integral $\iint \psi_M f \psi_N dS$, in which f is the function giving the boundary perturbation, and ψ_M and ψ_N are the wave functions concerned. To obtain free exchange between all pairs of normal modes, f must represent a random arrangement of patches or bumps having linear dimensions of the order of the wave-length. The results of this theory given by the index of randomness[3] are in a suitable form for use by practising architects. They include a formula for the critical frequency below which the sound is not well diffused. The critical frequency was shown to be related to the frequency giving maximum 'transmission irregularity'. The acoustical engineering aspect of this subject is, however, still in an early stage, and much more experience is needed in this field.

The course of lectures approached its conclusion with an account of the application of transient solutions of the wave equation to pulse recordings. Such a solution may be developed in the form of an asymptotic expansion, each term of which (after the first) corresponds to the appearance of a reflexion of the pulse, the time of arrival of each reflexion being determined. A new field of statistical investigation is thus opened up in which pulse records can be immediately interpreted, and in which new criteria of coherence and diffuseness become accessible. Although this approach to the problems of room acoustics is mathematically the most recondite, it is physically the simplest, and is the one normally used by architects. It remains to be seen whether its theoretical development will lead to simplifications of the technical side.

Inevitably, reference was made at various points in the lectures to the psycho-physical aspect of the subject. For example, work on the 'articulation index' for speech was described[6]. Tastes differ with regard to some of the subtler qualities of sound in buildings: qualities such as 'liveness' and 'tone' of music, and 'naturalness' of speech[6]. Much analytical work must still be done before objective standards can be laid down for good playing, speaking and hearing conditions.

Dr. Bolt's mastery of his subject was evident from the clarity and ease of his exposition. His audience and many other indirect beneficiaries owe their thanks also to the B.B.C., the Department of Scientific and Industrial Research, Mr. Joseph Emberton (Electrical Musical Instruments, Ltd.) and the L.C.C., whose gifts of money made it possible to invite Dr. Bolt to Great Britain. M. A. S. Ross

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VITAMIN C CONTENT OF AN OLD ANTISCORBUTIC: THE KERGUELEN CABBAGE

By H. H. HATT

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KERGUELEN Island, in the Antarctic Ocean, equidistant from South Africa and Western Australia, has a very limited flora, of which the Kerguelen cabbage (*Pringlea antiscorbutica*) is the most striking species. Captain Cook, who visited the Island on his third and last voyage, found "not a single tree or shrub anywhere" and would have given it the name Island of Desolation "but that I would not rob Monsieur de Kerguelen of the honour of it bearing his name". With Cook's interest in combating scurvy, it was certain that he would seek to use this plant as a vegetable. Anderson, Cook's surgeon, describes the plant and its use. "It was not much unlike a small cabbage" having "not only the appearance, but the watery acid taste of the antiscorbutics". It was eaten frequently raw, "but it seemed to acquire a rank taste by being boiled; which however our people did not perceive and esteemed good". Anderson recommended that it should be introduced into kitchen gardens and improved by cultivation[1].

Since then, descriptions of the plant and of its use as a vegetable have been prominent features in the records of explorers. Sir Joseph Hooker[2], of the Ross Expedition, found the cabbage one of eighteen flowering plants on the Island and "perhaps the most interesting plant procured during the whole voyage in the Antarctic". He was "unable to point to any close affinity which the curious genus may have with others of the same natural family (Cruciferæ)". He gave the first full description of the plant and was responsible for its unusual, and surely almost unique, specific name. Anderson had given the name *Pringlea* in honour of Sir John Pringle, who wrote a book on scurvy. Hooker says, "This latter circumstance has induced me at Mr. Brown's suggestion to assign the trivial name of antiscorbutica". Evidently the name was not given entirely to mark a special property of

the plant. Hooker is full of praise for the plant: "During the whole stay of *Erebus* and *Terror* in Christmas Harbour, daily use was made of the vegetable, either cooked by itself or boiled with the ships' pork . . . the essential oil gives a peculiar flavour which the majority of the officers and crew did not dislike and which rendered the herb more wholesome than the common cabbage for it never caused heartburn. . . ." Again: "Growing spontaneously and in so great abundance where it does, it is likely to prove for ages to come an inestimable blessing to ships touching at this distant isle". He was doubtful if it would be of value elsewhere because of its slow rate of growth.

A similar estimation of its worth was given by J. H. Kidder, of the U.S. expedition of 1874 in the *Monongahela*. He says "the leaves were eaten as cabbage by ourselves and the ship's company with relish. Our fowls were fond of them and they constituted the staple food of the live stock brought to the island"[3].

But if the strong cress-like taste did not offend the palates of British and American explorers, others were strong in condemning the cabbage. The Frenchman, Rallier du Baty[4], tells of his visit to the Island during 1907–8 and remarks: "I must not forget a peculiar plant we found . . . among the narrow belts of coarse herbage. It is called the Kerguelen cabbage. . . . We made use of it in our cooking. We had to boil its leaves twice before we could eat it, for it has the most rank and bitter taste very much like the most powerful horse radish. In the first boiling the water became of a dark yellow, but in the second boiling it is fairly clear and the cabbage becomes edible. We made sauces . . . and chopped it for the stew-pot." There would clearly be little ascorbic acid left after du Paty had cooked it.

The establishment by the Australian National Antarctic Research Expedition of a scientific station on neighbouring Heard Island presented an opportunity of investigating the ascorbic acid content of the cabbage, and in March 1949 members of the Expedition returned to Australia with plants collected on Heard Island, which they kindly made available. The plants had been potted in tins and carefully tended, but on arrival were yellowish and not in good condition. Many had flowered that summer. They were kept for a month and during this time improved in condition. Analyses were spread over a period of one month. Ascorbic acid was estimated on an extract in 4 per cent aqueous metaphosphoric acid by visual titration with 2,6-dichlorophenolindophenol. The extraction was made by maceration of the plant material for 1·5 min. in a 'Waring blendor' with seven times its weight of the metaphosphoric acid solution. The liquid was separated by centrifuging and titrated at once. Glass-distilled water was used for all the work. Tests showed that in the first extraction the ascorbic acid was evenly distributed between solid and liquid material and that subsequent extractions were unnecessary. The results are tabulated:

Plant material	Number of plants examined	Range of ascorbic acid contents (mgm./100 gm.)
Heart leaves	9	121–190 (average 155)
Middle leaves	7	100–143
Outer leaves	7	63–112
Old rhizomes	5	3–26
Young rhizomes	4	24–126

Reduction of the extract with hydrogen sulphide showed the absence of dehydroascorbic acid, and since the extract gave 92–93 per cent of its initial titre after keeping for 24 hr. at 20° C., very little dihydroxymaleic acid was present. Apparent vitamin C was estimated by Lugg's method[5] and by Snow and Zilva's[6] modification. Results agreed within 1 per cent and showed that in the outer leaves apparent vitamin C accounted for 7–8 per cent and in the heart leaves for 2–5 per cent of the ascorbic acid titre. The moisture content of the leaves ranged from 85 to 89 per cent and of the rhizomes from 84 to 86 per cent.

It is seen that the most edible portion of the cabbage, the heart leaves, are rich in ascorbic acid, the amounts present exceeding that found in most cabbages and being of the same order as that present in broccoli leaves and flower, and in parsley[7]. Eaten raw, the heart leaves would be a valuable anti-scorbutic. However, it is not an exceptional source of ascorbic acid such as the rose hip and the green walnut, which contain exceedingly large amounts. The ascorbic acid, particularly of the outer leaves, may be considerably higher in plants fresh from the field; the relatively low content of acid in the outer leaves may result from greater losses there. In the common cabbage the ascorbic acid content increases from inner to outer leaves[8].

Since the Kerguelen cabbage belongs to the Cruciferæ, it is of interest to discover if the seed fat of this isolated member of the family resembles that of other members and contains erucic acid as its major component. In a small sample of seed collected by the Expedition on Kerguelen Island, the fat content was 13 per cent. This liquid fat had a refractive index of n_D^{25} 1·4755, a saponification value of 184, and an iodine value of 144·8. It is hoped to report a fuller analysis later.

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PSYCHOLOGY IN SELECTING THE FACTORY WORKER

TWO papers on the psychological procedures in the selection of factory operatives were read to Section J (Psychology) of the British Association, at the recent meeting in Newcastle upon Tyne. The first paper, by W. S. Porteous, chief industrial psychologist to Rowntree and Co., Ltd., described procedures employed, and discussed the administrative difficulties met with, in running a selection programme in a large industrial organisation. The second paper, by R. F. Garside, one time research psychologist and statistician to Rowntree and Co., Ltd., and now at the University of Durham, described the statistical techniques employed in establishing a reliable procedure, examining the relationship of its

component parts and determining their validity for selection purposes.

The programme covering engagement, placement and promotion of operatives at the Rowntree Cocoa Works in York makes use of: (1) biographical questionnaire; (2) psychological tests; (3) a personal interview by a psychologist. The biographical questionnaire is suitably designed to cover details of the candidate's education, occupation and recreation. It carries a blank margin down one side for interview notes, and overleaf it is suitably prepared for follow-up purposes. The psychological tests include tests of intelligence, attainment in English and arithmetic, and specially designed aptitude tests. The two paper-and-pencil type intelligence tests used in engagement and promotion procedures take ten minutes and twenty minutes respectively and have been standardized on the factory population at large —percentile scores being available for different industrial groups. Distribution diagrams of these results indicate clearly the group difference in test scores.

A battery of sixteen performance tests that had been in use in the Rowntree works for many years, and for which were available test and re/test scores of a large number of girls, was examined for reliability. As age, interval between first test and re/test, and job done between testings might all have had a disturbing effect on re/test scores, these had to be taken into account in determining the test reliabilities. It was found by analysis of covariance that department (but not job worked at) and interval (but not subject's age) affected re/test scores. So all statistics were calculated within the departments and the effect of interval ironed out by multiple correlation technique based on the assumption that the multiple correlation of the hypothetical true re/test score upon the true first test score and interval equalled unity. Following this examination, six tests were retained, having satisfactory reliabilities, and they have been in use as part of the engagement procedure. The opinion has been formed that performance tests lasting a very short time (less than one minute) are too unreliable to be of any use in selection work.

A factor analysis was carried out on the six tests, plus a verbal intelligence test. The intercorrelations could be explained by postulating two common factors running through the tests and factors specific to each test. Most of the non-error variance of four of the tests was accounted for by the two common factors, whereas most of the non-error variance of the other three was accounted for by their specific factors. Accordingly, it was decided to use the first four tests as a composite test and the others separately.

The composite test of 'practical ability' is now given to all factory entrants and consists of two exercises in 'posting' a set of fifty coloured cards; a test of three trials on the Seguin form board, and an attainment on a figure board of twelve inset coloured squares to be filled by geometrical shapes of appropriate colour. The specific tests are: a ten-minute intelligence test, strength of grip on a dynamometer and a time reaction test. Three further tests of analogous type are also in use experimentally. They cover the factory job situations in which the operative is (1) being fed by a machine, (2) feeding a machine, (3) assembling small units to form larger units. Preliminary work has shown that these may give some help in placing operatives.

Besides biographical questionnaires, the selection programme includes a personal interview of candidates by a psychologist. The interview is regarded as having three aspects: in it the candidate enlarges on his application form; the psychologist endeavours to check the stability of the candidate; and both endeavour to come to an agreement on the most appropriate placing of the candidate. Interviews (apparently confirming the finding of Russell Frazer's report on the incidence of neurosis among factory operatives) have indicated that about one-third of women factory applicants for work require special consideration for placing and follow-up on grounds of personal instability. Studies on the validity of the selection programme at present in use have not been easy from an administrative point of view. Two criteria (ratings of operatives by supervisors; and amount of work done in a three-month period) were defined for this purpose in a recent investigation. The correlation between workroom ratings and a combination of interview assessment, verbal intelligence test score and strength of grip was 0·46. The multiple correlation of the same three items plus 'practical ability' test with the criterion of work done was 0·29. Although not high, these figures, in view of the unstable nature of both criteria, were considered satisfactory.

The general conclusion from the two papers and from the discussion that followed at Newcastle was that in a large industrial organisation of the kind described (one factory of several departments, and a total number of about eight thousand employees), selection and placing of operatives with the aid of questionnaires, psychological tests and interviews have important contributions to make to both the production of the factory as a whole and to the well-being of the employees as individuals. It is, however, essential that whatever the procedures adopted they should be both technically sound and administratively convenient.

FESTIVAL OF BRITAIN, 1951

SOUTH BANK EXHIBITION

THE Festival of Britain, to be held during May–September, 1951, will be a nation-wide demonstration of the leading achievements of Great Britain in the arts, sciences, technology and industrial design. The centre-piece of the Festival will be the Exhibition on the south bank of the River Thames between County Hall and Waterloo Bridge, and this will be mainly concerned with those contributions of science, technology and industrial design in which the prestige of Britain stands highest. Three other supplementary Exhibitions, two in London and one in Glasgow, will deal in more detail with architecture, science and heavy engineering respectively; and the amusement section normally associated with any large exhibition will be in Battersea Park, London. In addition, two Travelling Exhibitions will visit provincial centres during the Festival summer and will tell, in different language, the same story as that in the South Bank Exhibition in London.

Plans for this last-named Exhibition have recently been announced. The south-bank site covers only twenty-seven acres, which is very small in comparison with recent national and international exhibitions. Thus the display will necessarily be highly selective. The Exhibition will not be a trade fair where industries or businesses can buy display space; but instead it

will be organised into pavilions, each one of which will illustrate a particular theme; and only those subjects in which the British contribution is outstanding or unrivalled will be shown. The organisation of the Exhibition is in the hands of a team of experts representing science, architecture, exhibition technique and industrial design, which is known as the Presentation Panel, and which meets under the chairmanship of the director-general of the Festival. A Council of Science and Technology has been set up to represent the interests of the main branches of science, and the selection of currently manufactured exhibits is the responsibility of the Council of Industrial Design.

The site is divided by Hungerford Railway Bridge, and the Exhibition is based on this division by being laid out into two roughly semicircular sequences of buildings. The sequence lying upstream will illustrate the land and resources of Britain and what the people have derived from them, and that downstream will be concerned with the people themselves in their domestic surroundings. The main buildings of the Exhibition, some thirty in all, including restaurants and administrative buildings, but excluding the Concert Hall, are to be temporary structures. They will be constructed of a wide variety of materials and will contrast architecturally in colour and outline. The upstream area is to be the more formal in appearance, whereas the downstream area, in keeping with its theme, will wear a more domestic air.

The upstream sequence will be introduced by a section on the land of the British Isles, and following this will be sections designated and occupying areas (in square feet) as follows: country (32,000), natural resources (10,000), industry (33,000), seas and ships (24,000), transport (48,000), and the Dome of Discovery (99,767). The most striking building in this sequence (and, indeed, in the whole Exhibition) will be the Dome of Discovery. Designed to be the largest dome in the world, it will measure 365 ft. in diameter and 97 ft. in height. Its material, namely aluminium, will represent for this generation what sheet glass and cast iron did for the 1851 Exhibition, and the Dome will be as arresting in 1951 as was the Crystal Palace a hundred years ago. In it the story to be told is British pre-eminence in discovery and exploration, not only by land and sea, but also into the very nature of the living world and the universe. One section will display the latest knowledge of the structure and nature of matter, culminating in a display of nuclear energy, and others will be concerned with land, sea and polar exploration, inner space, outer space and the living world; all the sections will show appropriate industrial exhibits.

In the downstream sequence the sections and their corresponding areas (in square feet) are planned to be: character and tradition (10,715), homes and gardens (24,000), new schools (11,300), health (7,000), sport (5,300), seaside (approximately 10,000), the Shot Tower, the Telecinema and the Concert Hall. The last three are particularly interesting, especially the Shot Tower. This is a London landmark which survived the 'blitz' that razed this part of Thamesside during the War. Built like a lighthouse and designed originally for the manufacture of lead shot, it will be used to carry at its summit a 30-ft. diameter aerial of umbrella shape, which will be rotated by remote control from the 'outer space' section of the Dome of Discovery. With this radio telescope visitors in the Dome will be able to observe radio waves from the sun, stars and even meteors, and will be able to transmit radio signals to the moon and note their reflexion back to the earth a few seconds later. The Telecinema will be a small pavilion dealing with both cinematography and television; it will seat four hundred people for the showing of programmes, and is being built on very modern principles incorporating the most recent techniques in projection and acoustics.

The only permanent building on the whole site will be the new Concert Hall, which has been commissioned by, and will be the property of, the London County Council; this Hall will fulfil a long-felt want for a centre of culture on the south side of London. In fact, the development of the south-bank site for this Exhibition is being carried out in the closest collaboration with the London County Council, and the planning of roads, gas, water and electricity services, landscape, terracing, etc., is being made with a future long-term value definitely in mind. Such a point of view is very much in keeping with the spirit of the Exhibition.

AN ESTER WAX FOR USE IN THE TROPICS

By Dr. H. F. STEEDMAN
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In cutting histological sections in the tropics, the room temperatures during the day are in many cases so high that microtome work has to be done during the evening or at night. With paraffin wax the solution of this difficulty is usually sought in the employment of a wax of a higher melting point than that commonly used in temperate regions, because a higher melting point is usually correlated with a harder wax. Unfortunately, this means that material during infiltration is subjected to a much higher temperature than is desirable, waxes of 60–70° C. (140–158° F.) melting point being necessary.

The advantage of low-temperature infiltration yet with an exceedingly hard product as the final block is provided by using the following variation of the standard ester wax formula.

Diethylene glycol distearate	80 gm.	
Ethyl cellulose, low viscosity	4 gm.	
Stearic acid	5 gm.	m.p. 53° C.
Castor oil	4 gm.	
Diethylene glycol monostearate	5 gm.	

This wax is designed for use at room temperatures of 75–90° F. (*c.* 24–32° C.). Its performance at room temperatures of 75°, 85° and 90° F. is given below.

Room temperature 75° F.	Section range 4–25 μ Ribbon range 4–18 μ Compression at 8 μ is 12 per cent
Room temperature 85° F.	Section range 4–25 μ Ribbon range 4–25 μ Compression at 8 μ is 12 per cent
Room temperature 90° F.	Section range 5–25 μ Ribbon range 5–25 μ Compression at 8 μ is 14 per cent

The range of thickness of single sections and also of section ribbons at the three room temperatures cited should be sufficient for most purposes. It will be found that a microtome knife of first-class sharpness will give an improvement on these figures as well as reducing the compression percentage. The compression figures quoted are those derived from measurement of ribbons after flattening.

The performance of tropical ester wax at room temperatures lower than 70° F. is poor. It is not

designed for such use, and in order that it may not be confused in appearance with the standard mixture[1] it is being marketed with a trace of pink colour added to it[2].

The following points should be noted with regard to its use.

(1) For successful ribboning, ester wax should be cut much more slowly than paraffin wax. It is essential that the block sides should be straight and parallel, and that a stout, sharp knife should be used.

(2) The block should be warmed before trimming, otherwise the wax shatters and flies over the bench.

(3) After standing some weeks in the molten condition in an oven, a slight separation of the constituents may be seen. A little heating over a bunsen burner will make these pass into solution again.

(4) A clearer block is made if the wax is heated a few degrees above its melting point before being poured into the *L* moulds. The infiltrated specimen should be introduced into the mould when a thin skin of wax is seen next to the *L* pieces. Cool in water; but do not submerge.

(5) Tropical ester wax is soluble in alcohols, ethers, esters, ketones, hydrocarbons, etc. Ethylene glycol, mono ethyl ether or cedarwood oil are recommended as clearing agents.

[1] Steedman, H. F., *Quart. J. Micro. Sc.*, **88**, Third Series, No. 1.
[2] The British Drug Houses, Poole, Dorset.

SETTLING BEHAVIOUR OF THE OYSTER LARVA

THE larval habits and settling behaviour of the European flat oyster (*Ostrea edulis*) have been extensively studied at the Fisheries Experiment Station, Conway, where of recent years the work of Dr. H. A. Cole and his collaborators has given greatly improved techniques for breeding and rearing on a commercial scale. The task of reviving the depleted oyster fisheries in Great Britain is proving decidedly more difficult than that of similar fisheries on the other side of the Atlantic, where the American oyster (*Gryphæa virginica*) has proved more amenable to cultivation. The work at Conway now takes a further step forward with the publication by Dr. Cole and Mr. E. W. Knight Jones of the results of their investigations from 1939 onwards*.

In this noteworthy contribution to oyster biology two points of major significance emerge. The first is one the implication of which has a bearing on general problems of marine larval settlement, particularly those of gregarious species. The experiments showed that oyster larvæ tended to settle more readily on shells which already bore recently attached spat than on similar shells devoid of spat, especially so when the spat fall was not very intense. The authors suggest that settlement is encouraged by a substance secreted into the surrounding water by the spat and perhaps also by fully developed larvæ. If further experiments should prove that this suggestion is indeed fact, a significant advance will have been made.

The second discovery is of even more immediate importance to the oyster cultivator. It has long been thought that cultch intended to catch a spat fall should be perfectly clean and therefore should not be immersed until just before the larvæ are expected to settle. The results of experiments in comparing clean shells with shells already fouled by the settlement of other organisms completely contradicted this long-standing belief. In the experiments, larvæ settled abundantly on shells fouled with other sedentary organisms and in much less concentration on clean shells. Freedom from silt is, however, essential, and the practical problem for the cultivator resolves itself into how to produce a sufficient degree of fouling of his cultch to make it attractive without it becoming smothered in silt. It is evident that local conditions will greatly influence procedure, and that bouquets of tiles should remain largely free from falling silt in localities where shells scattered loosely over the bottom will quickly be covered.

This is a paper which no oyster cultivator can afford to ignore, and which no marine biologist interested in general problems of larval settlement and ecological distribution will forget.

* The Setting Behaviour of Larvæ of the European Flat Oyster (*Ostrea edulis* L.) and its Influence on Methods of Cultivation and Spat Collection. Fishery Investigations, Series 2, 17, No. 3. Pp. 39. (London: H.M. Stationery Office, 1949.) 2*s.* net.

THE MAYA CIVILIZATION OF YUCATAN

AT a meeting of the Royal Society of Edinburgh on October 24, an address on "The Maya Civilization of Yucatan" was given by Dr. Douglas Guthrie, of the Department of the History of Medicine, University of Edinburgh. He said that the Maya people have been called the 'Greeks of the West', a comparison which is fully justified. The study of the aboriginal inhabitants of America is only just beginning. Many cities still lie buried in the jungle, but the wonders of the sites already excavated, such as those at Chichen Itzá and Uxmal, reveal only a partial picture of the Mayan glory of the past. The civilizations of the Inca of Peru and of the Aztec of Mexico lacked the splendour of the Maya of Central America.

During the eighteenth and nineteenth centuries there was much argument regarding the origin of the races and cultures of America, resulting in a confused condition of American archæology which has continued to the present time. Inca and Aztec cultures were still in progress at the date of the Spanish Conquest, but that of the Maya, the greatest of the three, dating from A.D. 300 or earlier, had come to an end before the Spaniards landed. About 1843, publication of Prescott's account of the Conquest, and of the travels of Stephens and Catherwood, revealed to the world the existence, in the western hemisphere, of buildings comparable to those of Egypt and Greece.

Since then, each fresh discovery has added to the tale of Maya greatness. Their two most noteworthy accomplishments were the cultivation of maize and, probably deriving from this, the invention of a calendar. To this day maize, in the form of 'tortillas', remains the staple food of the so-called Indians. The remarkable ruins at Chichen Itzá include the pyramids, the ball-court, and various temples, many of them adorned with stone carvings of snakes, the feathered snake or plumed serpent being a favourite theme. The modern Maya, about a quarter of a million in number, are happy people, with a love of music and a sense of humour, although little remains of the ancient culture.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Radiography with Beta-Rays

SECONDARY electrons, generated by X-rays, have been used for producing shadow images of very thin specimens (Trillat[1], Tasker and Towers[2]). The use of other radiations (except X-rays), for example, alpha- and beta-rays, recoil atoms and accelerated ions for similar purposes does not seem to have been described. The rapidly increasing availability of radioactive nuclides makes the field very promising. A brief description of radiography with beta rays, for short 'beta radiography', is given below. A report on 'alpha radiography' experiments in this laboratory will be published shortly.

Several beta-emitting nuclides are suitable for radiographic purposes. Long half-life, absence of gamma radiation and high specific activity are desirable. In order to study specimens of different thicknesses we have used preparations of different penetrating powers as follows:

Nuclide*	Half-life	Maximum beta energy (MeV.)	Half-value thickness in aluminium (mgm./cm.²)
S^{35}	87 days	0·17	2–3
C^{14}	5,700 years	0·16	2–3
RaD+E	22 ,,	1·17	43
$Sr^{90}+Y^{90}$	25 ,,	2·35	110

* S^{35}, C^{14} and Sr^{90} were purchased from the Atomic Energy Commission, Oak Ridge, U.S.A.

Three methods for beta radiography have been studied. The most satisfactory one is to concentrate the beta source on to a small area and place the specimen, lying directly on the photographic emulsion, at some distance (5–10 cm.). Thus an almost parallel pencil of rays is used. Reduction of air pressure to 5–20 mm. mercury is necessary in most cases.

Fig. 1. Beta radiograph (positive) of part of a plant leaf (*Luzula multiflora* (Retz.) Lej.). Point source method with 0·5 millicurie sulphur-35. Exposure 70 hr. Magnification 7 ×. Negative material: Gevaert Positive Fine Grain film. Finest hairs are of the order 15 μ

Fig. 2. Beta radiograph (positive) of a skarn mineral (plane parallel specimen) containing magnetite (dark areas), hornblende and other silicates (grey areas). Grid method using a surface-plated radium D+E source. Magnification 6 ×. Ilford *C* X-ray film

Fig. 3. Beta radiograph of a piece of mica. Sulphur-35 point source. Magnification 4 ×. Gevaert Positive Fine Grain film. The terrace formation in the mica is readily seen. Thickest part is of the order 30 μ

The two other methods require a preparation uniformly spread over a certain area (we use 1 cm.²). One involves direct contact, with the source on the specimen and emulsion. The other uses a moving grid (modified Potter–Bucky grid used in X-radiography) between the plane source and the specimen.

The direct contact method is the fastest one, but does not give so good resolution as the other methods. Some results are presented in Figs. 1–3.

Continuous beta radiation is absorbed in matter approximately according to an exponential law for at least a part of the practical range. According to our measurements, the exponential part is the first third of the practical range for parallel phosphorus-32 beta-rays. The mass absorption coefficient was found to increase by a factor of two from carbon to lead. This means that the different parts of a specimen to be radiographed will transmit rays according to their density and mean atomic number. Fig. 2 illustrates an application of the last-mentioned feature. If the specimen is of varying thickness and homogeneous composition, the radiograph will show the thickness distribution, as can be seen from Fig. 3.

The resolution obtainable is limited by scattering of the beta-rays in the specimen itself. A diffuse zone of the order of half the specimen thickness must be expected for high atomic numbers. Because of intensity difficulties, we have not been able to use emulsions with the finest grain available. We have used Gevaert Positive Fine Grain film, Ilford Hyperchromatic film and Ilford X-ray film type *C* with one of the two coatings removed.

The main features of beta radiography are the very inexpensive and rather simple equipment, compared to X-ray apparatus, and the increasing possibilities of obtaining suitable radiation sources even in large quantities. The use of parallel beta-rays should yield greater resolution than the 'secondary electron radiography' mentioned above. The technique is suitable for the study of thin layers of material such as metals, plastics, textiles, etc., phase studies in metallurgy and mineralogy, biological and histological specimens, paper chromatography, etc. The thickness-range accessible is roughly 1–700 mgm./cm.². The experiments are being developed towards giving quantitative results.

A more detailed description of the experience gained will be published elsewhere. This work was supported financially by the Swedish State Council of Technical Research.

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[1] *Rev. Sci.*, **8**, 364, 370 (1942). *J. App. Phys.*, **19**, 844 (1948).
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A Test of the Interpretation of X-Ray Patterns of Micelles

CLEAR transparent solutions of soaps and detergents give characteristic X-ray patterns, due to the colloidal micelles formed by association of ions or molecules or both. There is still, however, no agreement about the number and kinds of micelles which can be present[1]. Hess and Gunderman[2] were the first to explain the X-ray patterns upon the basis of lamellar micelles consisting of double layers of molecules separated by equally spaced layers of water. Harkins[3] recently directed attention to a so-called '*M*-band' in the pattern and attributed it to diffraction from the double-leaflet alone.

The following experiments with a double-leaflet of lead stearate show that it is indeed possible for a double-leaflet to give an *M*-band.

The film of lead stearate was deposited on a thickly chromium-plated, slightly curved brass slide from monolayers of 'stearic acid' spread on a saturated solution of lead chloride at *p*H 5·5, following the procedure of Clark and Leppla[4]. Either 'oleic acid' or castor oil was used as piston oil. The multilayers were placed at an angle of grazing incidence in a slit camera as used in the X-ray investigation of solutions of detergents, with a distance of 200 mm. between specimens and film. Thus a single double-leaflet or any multiple thereof could be examined and the patterns compared with those from solutions.

A single double-leaflet gave, after 17 hr. exposure, a faint but distinct diffraction pattern in three orders, definitely *less* intense than micelle patterns, in spite of the presence here of lead atoms, but comparable with the rather indistinct *M*-band.

As the double layers were multiplied, the multilayers gave much more intense patterns, quite comparable with those of micelles. Comparison with a multilayer consisting of twenty-five double layers showed that the positions of all the *lines* of the diffraction pattern are *independent* of the number of layers and are identical with the powder pattern of solid lead stearate, the long spacing of which is 49·5 A. This enables us to decide another disputed question. It has sometimes been proposed to apply a correction factor of 1·23 to Bragg spacings in solutions of detergents, as in those of fluids[5]; but it is evident from the present results that 1·23 should *not* be applied.

The occurrence of higher orders in patterns from multilayers of *solid* lead stearate, and their absence in micelles, can be readily explained by taking into account the thermal motion of the micelles and the high electron density of the lead atoms[6].

A detailed report of this investigation will appear elsewhere. We are grateful to Prof. J. W. McBain for advice and the facilities of his laboratory. One of us (J. T. D.) is indebted to the Bristol Myers Co., the other (W. P.) to Lever Brothers Co., for the award of the fellowships.

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Aug. 1.

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Variable Colour-Amplitude Phase-Contrast Microscopy

SEVERAL variable phase-contrast systems have been described. Most of these make use of polarized light in order to obtain variation of phase or amplitude, or both[1]. An experimental microscope has been constructed by Messrs. Cooke, Troughton and Simms, Ltd., which allows the operator to obtain positive or negative phase-contrast at will, and to control the intensity of either the direct or diffracted light. A 'Soleil' compensator enables retardations ranging from $+\lambda/4$ to $-\lambda/4$ to be introduced. A full description of this instrument[2], together with an account of the work carried out with it in this laboratory, will appear shortly[3].

A system of this type affords the possibility of introducing a difference of colour between the direct and diffracted light. This can be done by using a dichroic filter in place of either the polarizer or the analyser. Recent work, carried out in collaboration with Mr. D. Anderson, of the British Scientific Instrument Research Association Laboratories, has resulted in the production of a very large number of strongly dichroic filters. These were made by staining stretched cellulosic films with various dyes. With suitable combinations of such filters it is possible to have the light passing through the phase annulus, say, green, whereas that passing through the rest of the objective (the diffracted light) is, for example, red. As the polarizer or filter is rotated these colours reverse. Were these colours 'pure', no phase-contrast effects would be obtained, as the conditions necessary for interference could not exist. However, in actual fact, the transmission spectra of the filters usually overlap considerably, so that phase-contrast is possible over the common spectral range. Superimposed on this phase-contrast effect, we have what is essentially 'differential colour illumination' described by Rheinberg[4]. This results in the background and broad detail (carried mainly by the light which has passed through the annulus) appearing in one colour, while fine detail and regions of discontinuity of phase-change appear in another.

A full evaluation of the method must await the construction of a special objective with polarizing elements incorporated in the phase plate. Most of the systems hitherto described make use of quartz or other birefringent materials which may introduce complications such as rotary dispersion and dispersion of birefringence. Nevertheless the results so far

obtained indicate that it is worthy of further investigation.

A more detailed description of the dichroic filters and their use in various methods of microscopy will appear elsewhere.

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Aug. 4.

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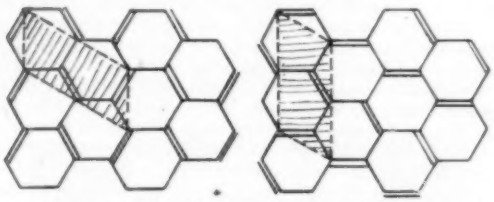
Structure of Graphite

In the electron diffraction patterns formed by single crystals of graphite (transmission) we have discovered new spots which would be indexed $(\frac{1}{2}00)$ or $(\frac{1}{2}\frac{1}{2}0)$ (and their symmetrical associates) in the usual unit cell. These new spots are very weak (perhaps a hundred times less intense than the strong (100)); they appear in all the graphites (Ceylon, Madagascar, Canada) tested. They do not appear in similar structures such as molybdenite; thus they are not due to electrons of twice the velocity indicated by the accelerating potential.

These new spots are not connected with the layer arrangement or disarrangements described by Lipson and Stokes[1] and studied in single crystals by Hoerni[2]; they oblige us to take a unit cell twice as large as the usual one in the *basal plane* (the layer arrangements have changed the height of the unit cell).



Possible arrangements of double bonds (the shaded part represents the unit cell)

We offer the following tentative explanation. The double bonds between the carbon atoms resonate between structures such as those shown in the accompanying diagram, giving a unit cell twice as long as the usual one in one direction and then in another, doubling the cell on the average. The fact that extra spots appear only for low indices seems to indicate that the unequal distribution of the outer electrons is responsible for them.

So far, we have been unable to see a phase relationship between the assumed positions of the double bonds in different layers, because spots of the type $(\frac{1}{2}0l)$, where l is non-integral, always appear when the crystal is turned from the position normal to the beam.

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July 6.

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Luminescence of Barium–Strontium Oxide

The application recently of the semiconductor model to the oxide cathode used as a thermionic emitter in vacuum tubes directs attention to the possibility of observing luminescence in such materials.

Luminescence has been observed in this Department in a special valve constructed by E. Hopkins for other purposes, and I have carried out measurements on the characteristics of this luminescence in specially constructed valves. Well-activated oxide cathodes of barium–strontium oxide were found to give a pale blue fluorescence under electron bombardment, and spectrographic measurements show a broad intensity maximum at 4900 A., the total emission spectrum extending from 4600 A. to 5400 A. The intensity of the emitted radiation decreases as the temperature of the barium–strontium oxide is increased, falling rapidly at 700° K., and no appreciable luminescence is observed at 800° K. Preliminary measurements indicate that afterglow is negligible, showing the absence of any electron-trapping mechanism.

Detailed investigations are being carried out using both electron bombardment and ultra-violet light excitation, on activated and unactivated oxide cathodes; and it is considered that such measurements will give useful information on the energy-levels in barium–strontium oxide. Such information is necessary for a full explanation of the properties of the oxide cathode.

Acknowledgments are made to the Radiophysics Division of the Commonwealth Scientific and Industrial Research Organisation, special valves being constructed in the Valve Laboratory of the Division.

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An Application of Resistance Networks to the Problem of Adjustment by Least Squares

It is well known that the normal equations for the least squares adjustment of networks of spirit-levelling and similar observations can be solved very simply by relaxation[1]; but the determination of the standard deviation of the n heights requires the solution of n sets of n simultaneous equations, and by any numerical method this is more laborious than the determination of the heights themselves. If σ is the standard deviation of an observation of unit weight, the standard deviation of a height h_i is $\sigma\omega_i^{1/2}$, where ω_i, the reciprocal of the weight of h_i, is the solution of an equation of the form

$$(x_1 \ldots x_{i-1}, \omega_i, x_{i+1} \ldots x_n).\ \mathbf{A} = (0, \ldots 0,1,0 \ldots 0).$$

A in this set of equations is the matrix of the coefficients of the normal equations and, therefore, known. Now, if a network of resistances is constructed which is topologically identical with the network of levelling, and is such that the admittance of each element is proportional to the weight of the corresponding observation, the admittance matrix will be proportional to **A**, and the above equation becomes the equation for the voltage appearing between the initial point and the ith point, when unit current is injected between these two points. Unlike Liebmann's applications of resistance networks to the solution of partial differential equations[2], no high

accuracy is required because the weights of the observations are not sufficiently well known to justify it, and ordinary carbon resistors will usually be satisfactory.

The method was devised for the adjustment of networks of observations of differences of gravity, three of which contained respectively nine, fifteen and fifteen nodes, and the numerical details will appear in a publication which is in preparation (see also refs. 3 and 4).

In conclusion, I wish to thank the Department of Scientific and Industrial Research for a grant enabling me to take part in the gravity surveys.

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July 27.

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Normalization of Frequency Functions

A method of dealing with non-normal frequency distributions consists of transforming the original variable in such a manner that the transformed variable has a normal distribution. Early writers on this topic were F. Y. Edgeworth and J. C. Kapteyn. In practice, the original law of distribution is unknown, and from our observations we have to choose the form, and estimate the parameters, of a suitable transformation.

May I direct attention to the following technique, which has been found on occasion to give satisfactory results, as judged by the chi-squared test of goodness of fit, without an undue amount of computational labour.

x is a continuous stochastic variable, with probability density $p(x)$. Its range is divided into $k+1$ class intervals $x_{i-1} < x \leqslant x_i$, $i = 1$ to $k+1$, and out of n observations, f_i fall within the ith class interval.

Defining $y_i = \frac{1}{n}\sum_1^i f_i$ and $\alpha_i = \int_{-\infty}^{x_i} p(x)dx$, it is found, for $n \to \infty$, that the y_i, for $i = 1$ to k, are normally correlated with true means α_i and covariances $\alpha_i(1-\alpha_i)/n$, where $j \geqslant i$.

Then, if $y_i = \int_{-\infty}^{z_i} \varphi(t)dt$ and $\alpha_i = \int_{-\infty}^{\beta_i} \varphi(t)dt$, where $\varphi(t) = \frac{1}{\sqrt{2\pi}} e^{-t^2/2}$, it is found, for $n \to \infty$, that the z_i are normally correlated with true means β_i and covariances $\frac{\alpha_i(1-\alpha_j)}{n\varphi(\beta_i)\varphi(\beta_j)}$, where $j \geqslant i$ and $i = 1$ to k.

The 'observed' points (x_i, z_i) lie near the curve of the means, $z = f(x)$ say, which contains the points (x_i, β_i). $z = f(x)$ is the transformation sought[1], since z is normally distributed. It remains to choose a suitable form for $f(x)$ and to estimate its parameters.

A simple assumption is $f(x) = \sum_1^l \gamma_j x^{j-1}$, where $l < k$. On occasion, $l = 4$ or $l = 6$ was found to be satisfactory. Then $\beta_i = \sum_1^l \gamma_j x_i^{j-1}$, and denoting estimates of γ_j by $\hat{\gamma}_j$, these were taken to be the solutions of the equations $X'CZ = X'CX\hat{\Gamma}'$, where x is the matrix $\| x_i^{j-1} \|$, C^{-1} the matrix $\left\| \frac{\alpha_i(1-\alpha_j)}{n\varphi(\beta_i)\varphi(\beta_j)} \right\|$, Z' the vector (z_i) and $\hat{\Gamma}'$ is the vector $(\hat{\gamma}_j)$.

These $\hat{\gamma}_j$ are, for $n \to \infty$, normally correlated, with true means γ_i and coefficient matrix $X'CX$. Thus, if the proposed transformation is found to be satisfactory, we then have the correct asymptotic sampling distribution of our estimates of the parameters which appear in it. In computing the $\hat{\gamma}_j$, the unknown α_i and β_i were replaced by the y_i and the z_i respectively. It is considered that for large n the resultant loss of efficiency in the estimates is negligible. The method is useful for psychologists who wish to work from raw scores x to normalized scores z and back again.

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Friction and Adhesion of Clean Metals

It is now well established that the development of high friction and ultimately of seizure between rubbing metal surfaces is greatly facilitated by progressive cleaning, particularly in the final stages when the last remaining contaminant films of atomic dimensions are removed. We have recently carried out further experiments on the lines of those of Bowden and Hughes[1], originally with the object of determining the temperature coefficient of friction over a wide temperature range, and have found that with clean surfaces complete seizure occurs.

In our present apparatus, two separate pieces of metal are heated by high-frequency induction to the point of evaporation in a vacuum of about 10^{-6} mm. mercury. They are then allowed to cool nearly to room temperature and are slid together without disturbing the vacuum. The normal load is about 15 gm., and the point of contact is localized by one surface being convex. Using pure nickel, we find that complete seizure occurs. Similar results are observed with pure iron and with platinum. There is evidence with iron that, at room temperature, the contaminant film formed even under these conditions can reduce the friction to $\mu = c.\ 3{\cdot}5$. If the metal is heated to $c.$ 300° C., however, the contamination is sufficiently reduced for complete seizure.

An interesting observation is that under these conditions the sliding process itself leads to a very great increase in the true area of contact. The 'coefficient of friction' (μ) may rise to 100 or more, as compared with $\mu = 6$ in the earlier experiments[1]. The normal force required to separate the metals has been measured and the area of contact deduced from photomicrographs. It is found that the contact has the bulk strength of the metal, typical figures for iron being 1·18 kgm. over 0·0187 mm.^{2}, equivalent to 63 kgm./mm.^{2} or 40 tons/in.^{2}.

From these results we may conclude that, although our surfaces are probably not absolutely free from an adsorbed monolayer, this residue offers small resistance to the adhesion and recrystallization between

metal surfaces in contact. It is possible that such a layer is easily broken up, especially on soft metals where plastic deformation at the points of real contact is relatively great. Alternatively, it may be sufficiently thin to permit migration of metallic atoms with the formation of a complete bond.

We thank the Metropolitan-Vickers Electrical Co., Ltd., for the gift of an induction furnace, and the Ministry of Supply for support.

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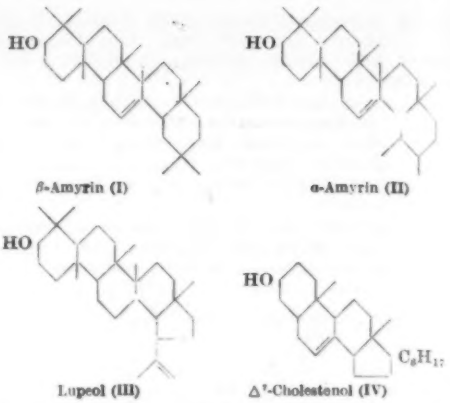
Structure of the Triterpenes: an Interrelationship between the Lupeol and the β-Amyrin Series

Due mainly to the extensive and brilliant researches of Ruzicka and his school, a large majority of the well-characterized triterpenoid compounds have been classified as being related to one or other of the three isomeric alcohols, α-amyrin, β-amyrin or lupeol, and their relationships with these three parent compounds have been rigorously established[1]. Such a grouping is also indicated by the results of studies of molecular rotation differences[2].

The structures of the three parent compounds have yet to be finally established. Most progress has been made in studies with β-amyrin, and structure (I), originally suggested by R. D. Haworth[3], is now favoured for this compound. For α-amyrin, which is generally similar in many of its properties to the β-isomer, the closely related structure (II) has been proposed[4].

The properties of lupeol, on the other hand, especially in so far as the unsaturated centre is concerned, differ rather sharply from those of the amyrins. Various structures have been proposed; but the amount of evidence available to date has scarcely justified more than very tentative formulations. However, representation by formula (III) can now be said to explain the majority of reactions of compounds of this series.

In attempts to convert lupeol derivatives into compounds more susceptible to degradation by conventional methods, isomerization reactions under the influence of acidic reagents have been studied. After a prolonged investigation of the reaction conditions, it has been found possible to isolate two isomerides in c. 40 per cent yields from the treatment of lupenone with sulphuric acid in acetic acid–benzene solution. Under the mildest conditions, that is, at 20° for seven days, lupenone is converted into lupenone-I, which on further treatment with the same reagents gives lupenone-II, also obtained under more vigorous conditions directly from lupenone. When the carbonyl group of lupenone-II is converted to a methylene group by the Wolff–Kishner procedure, a hydrocarbon, lupene-II, m.p. 191–192° (corr.) $[\alpha]_D^{20°} - 34°$, is obtained. This hydrocarbon has been found to be identical with β-amyrene-III, obtained by Winterstein and Stein[5], either by reduction of β-amyrone with amalgamated zinc and hydrochloric acid or by isomerization of β-amyrene-IV with the same reagents. No melting-point depression was observed with a mixture of lupene-II and the hydrocarbon prepared by Winterstein and Stein's procedure, and the infra-red spectra (see diagram) determined in 'Nujol' paraffin were indistinguishable. In addition, it may be noted that the infra-red spectrum indicates that the ethylenic linkage in lupene-II must be of the tetra-alkyl substituted type.

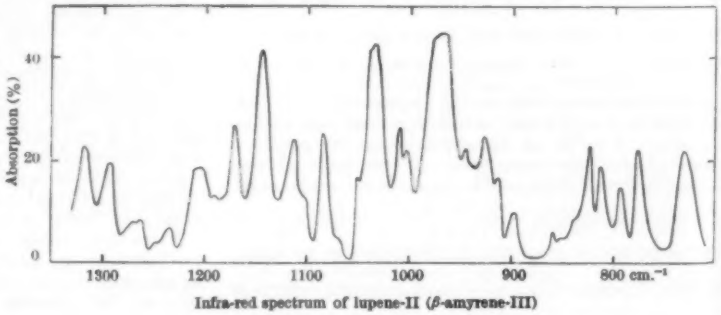


β-Amyrin (I) α-Amyrin (II)

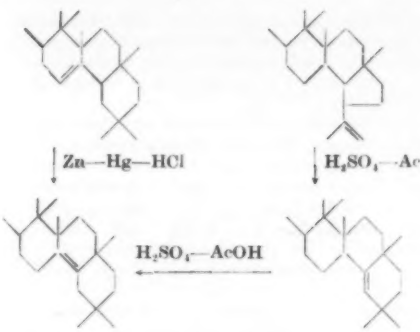
Lupeol (III) Δ⁷-Cholestenol (IV)

The rearrangements which are believed to be involved in the formation of this common hydrocarbon from both β-amyrin and lupeol are indicated in the accompanying partial formulation. Much evidence in support of this scheme has already been obtained and will be published elsewhere in due course. Assuming that β-amyrin is correctly represented by (I), then it seems highly probable that representation of lupeol by (III) will prove to be satisfactory. It can certainly be said that the carbon skeletons and stereochemistry of rings *A*, *B* and *C* are identical in the two series.

The double-bond migrations involved in the interconversions indicated above seem to be closely akin to those well known to occur in rings *B*, *C* and *D* in the steroid series. In fact, we believe that the analogy between β-amyrin and the Δ⁷-stenols (for example, IV) will prove to be exceedingly close, and that this correlation with the steroid series will result in a



Infra-red spectrum of lupene-II (β-amyrene-III)



rapid final solution of the remaining details of triterpene structure.

We are most grateful to Dr. H. P. Koch and Miss J. M. Fabian, of the British Rubber Producers' Research Association, for carrying out the infra-red examination.

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Molecular Rotation Contribution of C(17) in the Steroid Skeleton

Fieser and Fieser[1] have recently deduced molecular rotation contributions for the various asymmetric centres in the steroid skeleton. Their values for the contribution of C(17) were obtained, in the absence of data permitting direct comparison, from the molecular rotation of cholestane by subtracting the contributions of all the other asymmetric centres, some of which (those of C(9), C(10) and C(13)) appear to be unreliable.

The rotation contributions (Δ) of C(17) can now be estimated more simply and reliably by comparing the molecular rotations, $[M]_D$, of androstane, *5-allo*-pregnane and *5-allo*-17-*iso*pregnane, the last-named compound having recently been prepared by Casanova and Reichstein[2].

$[M]_D = [\alpha]_D \times$ mol. wt./100; all values are determined in chloroform

Compound	Grouping at C(17)	$[M]_D$	Δ	Ref.
*5-allo*Pregnane	CHEt (β)	+ 52°		2, 3
Androstane	CH_2	+ 5°		4
Contribution of C(17) carrying a (β)-ethyl group			+ 47°	
5-allo-17-*iso*Pregnane	CHEt (α)	− 95°		2
Androstane	CH_2	+ 5°		4
Contribution of C(17) carrying an (α)-ethyl group			− 100°	

The contributions of C(17) thus calculated are not equal in magnitude, presumably owing to vicinal action of the asymmetric centres at C(13) and C(14). The values for the contributions of C(17) calculated indirectly by Fieser and Fieser (± 35° for β- and α-substituents respectively) are of the same sign and the same order of magnitude as those given above.

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Reactivity of Different Faces of a Copper Single Crystal

By using single-crystal metal spheres, Hausser[1], Tamman and Sartorius[2], and in particular A. T. Gwathmey[3] and his collaborators, have demonstrated the marked differences in the physico-chemical properties of the surfaces of a crystal. I have extended their techniques to reactions in which crystals may be etched by vapours. A single crystal of the substance under examination is allowed to react with gaseous reagent under conditions of temperature and pressure such that the product is volatilized away as fast as it is formed. For example, a single crystal of pure copper was electrolytically polished and subjected to the action of a halogen vapour at 444° C. and about 1 mm. pressure. Under the conditions of the experiment the cuprous halide sublimed away continuously, leaving a clean, etched copper surface. Etch pits were produced with their reflecting surfaces (micro-facets) parallel to certain crystallographic planes, so that, on rotating the sphere in a parallel beam of light with the eye looking along the beam, reflexions were seen at certain orientations. It was thus possible to identify easily the facets produced and, by roughly comparing the intensities of the reflected beams, to judge which predominated.

In general, the facets exposed were (111), (011), (012) and (001). In all cases the reflexions from (111) and (011) were strong and that from (001) very weak. With iodine and bromine the (012) reflexion was also strong; but with chlorine it was weak.

Normally the facets were not uniformly distributed, but arranged in patterns as with etching by acids, etc. These patterns were related to the symmetry of the crystallographic axes concerned. Two typical examples are shown diagrammatically.

Copper single-crystal spheres, electrolytically polished, then etched by bromine at 444° C. (1) View along (111) direction with illumination by beam of light parallel to that direction. The regions marked *E* are the 'cube edge' areas and are centred on the (011) poles. The regions marked *C* are 'cube face' areas and are centred on the (001) poles. Both reflect light back along the (111) direction. The dark areas, which do not reflect in this direction, are centred on the (012) poles. (2) View along (001) direction showing illuminated. Only a small square diffuse patch reflects light back

In the presence of oxygen, the patterns disappeared and the surface became mat, that is, the facets were uniformly distributed; but the same reflexions were obtained in the same relative intensities.

Further work is in progress to determine which of many possible explanations for these phenomena seems most likely, and results will be reported in greater detail elsewhere; but the method in itself opens up a number of possibilities. Reactions between solids and vapours may be studied without complications due to a layer of product, and since the microfacets are produced early in the reaction and remain throughout its course, kinetic considerations may be rendered simpler by having to take into account only facets containing known spatial arrangements of atoms. The micro-facets may be identified and their relative areas estimated optically. The modification by oxygen of the reactions between copper and the halogens indicates that it may throw light on the chemisorbed state. It may be possible to prepare clean surfaces (or surfaces with only a monolayer of reagent) with known facets, edges and corners for work on catalysis, etc. By comparison of the effects of a series of reagents together with that of actually evaporating material from the surfaces of the crystals themselves, it may be possible to get some idea of the 'residual valencies' (electronic states) at crystal surfaces.

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Poly-arginine

The high content of arginine residues in protamines (salmine, for example, contains 85–88 per cent arginine[1]), the low molecular weight of these strongly basic proteins, and the accumulating data on the polymerization of N-carboxyl anhydrides of α-amino acids[2], led us to a systematic study of the possibilities of synthesizing poly-arginine. In the present communication, we wish to report the preparation of poly-arginine by guanidization of poly-ornithine. The latter was synthesized in the manner previously described for its homologue, poly-lysine[3].

The synthesis of poly-arginine is indicated in the scheme below.

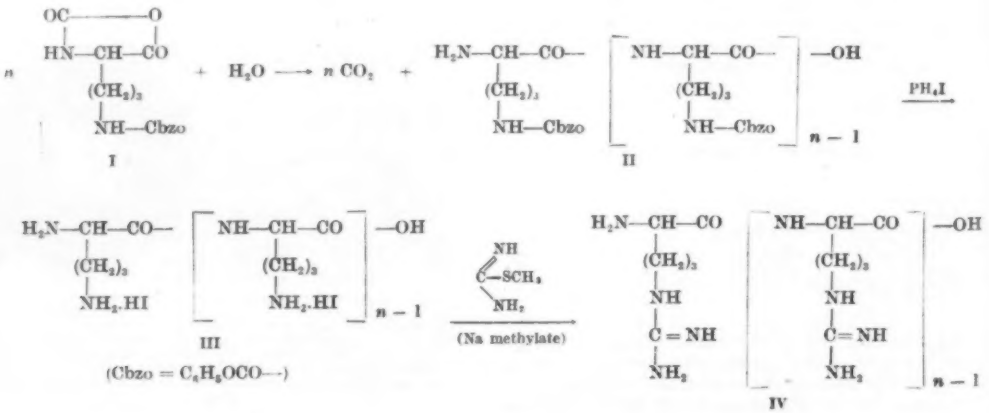
δ-Carbobenzoxy-α-N-carboxyl ornithine anhydride (I) was prepared from α,δ-di-carbobenzoxy-ornithine (cf. ref. 4). (I), when carefully dried *in vacuo*, melts at 110° C. and undergoes rapid polymerization, with evolution of carbon dioxide, yielding poly-carbobenzoxy-ornithine (II), as a hard, transparent, glassy mass. The average molecular weight of (II) was calculated from its amino-nitrogen content (Van Slyke). The highest polymer of (II) so far synthesized contains on the average twenty-six ornithine residues.

On reduction with phosphonium iodide, (II) yields poly-ornithine hydriodide (III). Like poly-lysine hydriodide[3], (III) readily dissolves in water, gives positive ninhydrin and biuret reactions and a negative picric acid test. (III) contains practically no free ornithine, and on hydrolysis yields ornithine quantitatively.

Poly-arginine (IV) was obtained on guanidization of (III) with a large excess of methyl *iso*thiourea in methanol, according to Christensen[4]. At the start of the reaction, poly-ornithine could be precipitated from the reaction mixture as the flavianate by means of flavianic acid. As the guanidization proceeded, the precipitate obtained with flavianic acid contained increasing amounts of polyarginine flavianate. The course of guanidization was followed by the determination, in the precipitated flavianate, of the decrease in amino-nitrogen (Van Slyke), the increase in total nitrogen (Dumas) and the increase in arginine content (Sakaguchi[5]). Under the experimental conditions used, guanidization of (III) was complete at room temperature within five to six hours.

Poly-arginine flavianate is soluble in hot water, insoluble in boiling methanol and insoluble in benzene. Upon hydrolysis the flavianate yields the theoretical amount of arginine. On treatment with sulphuric acid and extraction of the flavianic acid with butanol, poly-arginine flavianate yields poly-arginine sulphate. Poly-arginine sulphate readily dissolves in water, gives positive Sakaguchi, ninhydrin and biuret reactions and a negative picric acid test.

No final conclusion can yet be drawn as to the presence of a free α-amino end group in polymer (IV), as this group may also undergo guanidization in the course of the reaction.



A full description of the present experiments and of the chemical and enzymatic behaviour of poly-arginine will be published elsewhere.

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Separation of Vanillin and Syringaldehyde by Paper Partition Chromatography

THE separation of vanillin and syringaldehyde produced by the oxidation of lignins with nitrobenzene in alkaline medium is of importance in lignin chemistry. Spruce lignin gives only vanillin[1], whereas hardwood lignins give both aldehydes in relative quantities depending on the species[2]. Only limited success has attended efforts to separate them by chemical means[2,3]. Separation by vacuum sublimation[2] employs 0·4 gm. of the mixed aldehydes and requires specialized equipment. The present communication shows that separation can be effected by paper partition chromatography using petroleum ether saturated with water as the mobile phase.

The capillary ascent method of Williams and Kirby[4] has been adapted to effect the separation, as follows. The apparatus consists of a 17-cm. diameter Petri dish lid and a cylindrical tank, 25 cm. diameter by 50 cm. deep, fitted with a water-sealed lid. The Petri dish, containing 100 ml. of petroleum ether (b.p. 100–110° C.) saturated with water, is placed on the bottom of the tank, which has previously been just covered with water saturated with petroleum ether. Drops of about 10 mgm. of a 2 per cent solution of the aldehydes in alcohol are placed about 2·5 cm. from the edge of a sheet (*c.* 28 cm. by 46 cm.) of Whatman No. 1 filter paper and allowed to dry out at room temperature. Eight drops can conveniently be placed along the 28-cm. edge. The paper is fastened into the form of a cylinder and placed on end in the Petri dish, the aldehyde spots being just above the level of the petroleum ether. The lid is then placed on the tank. After the fractionation has proceeded for 16 hr. at about 20° C., the paper is removed from the tank and the limit of excursion of the solvent marked; this must be done quickly as the solvent is soon lost from the paper by evaporation. It is dried in air for one hour and developed by spraying with 0·4 per cent solution of 2,4 dinitrophenylhydrazine in 2*N* hydrochloric acid.

The accompanying reproduction shows the excursion of samples of vanillin and syringaldehyde in comparison with the excursions of the constituents of the aldehyde mixtures derived from the woods of *Eucalyptus resinifera* Sm. and *Eucalyptus diversicolor* F. v. M. R_F values obtained were: for vanillin, 0·32; for syringaldehyde, 0·12. The method has proved most useful for qualitative testing of the aldehyde mixtures obtained from the oxidation of woods and lignins, and the possibility of making it quantitative is being investigated.

This work is part of the programme of the Division of Forest Products, Commonwealth Scientific and Industrial Research Organisation.

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Commonwealth Scientific and
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July 8.

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Occurrence of Dulcitol as Exudate from *Euonymus japonicus* and *E. europæus*

DURING the long period of drought and abnormally high temperatures of June and early July 1949, many bushes of *Euonymus japonicus* in the Bristol area were observed to possess a white incrustation on the upper surface of the leaves. In cases of weakly growing bushes, almost all leaves were affected; but generally the heaviest incrustation occurred on relatively few leaves and appeared to be a dried exudate, probably due to damage by aphides, which were very prevalent. The incrustation was found mainly near the base of the leaves, and typical examples (see photograph) show the nodular nature of the material, which was easily dislodged from the smooth surface.

Examination of the exudate, of which as much as 0·2 gm. was obtained from a single leaf, showed that it consisted of crystalline dulcitol (galactitol),

$CH_2OH.(CHOH)_4.CH_2OH$, in a high state of purity. Selected pieces had melting point 175–180°, and gave pure dulcitol (melting point and mixed melting point 187–188°) by one crystallization from water. Further confirmation of the material as dulcitol was obtained by the formation of the hexa-acetyl derivative which, after crystallization from alcohol, had melting point and mixed melting point 168–169°. More dulcitol in a slightly less pure state was obtained by washing the stripped leaves with warm water and evaporating.

A similar but less pure exudate consisting largely of dulcitol was also found on many spindle trees (*Euonymus europœus*); but it was more thinly and evenly distributed over the leaves and twigs and tended to be sticky (see photograph).

Under ordinary conditions most of the dulcitol would doubtless be dissolved and washed away by rain, and even in a sheltered place, under the more normal humid conditions it becomes sticky, largely translucent and much less noticeable.

Dulcitol is of fairly frequent occurrence in Nature, and has previously been described as occurring in the honeydew of *Euonymus japonicus*, and in the twigs and fruits of *Euonymus europœus*; but conditions in Great Britain can seldom have been so favourable to its accumulation as the early summer of 1949.

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Volatile Fatty Acids in Portal Blood of Sheep

VOLATILE fatty acids—chiefly acetic, propionic and butyric acids—are formed as a result of the fermentation processes in the rumen of sheep and are absorbed through its wall. With the purpose of investigating the concentration of these acids and other constituents in the portal blood during a digestion cycle, that is, the 12-hour period after feeding, a slightly modified London canula was fixed adjacent to the main trunk of the portal vein of two sheep[1], which had previously been provided with a rumen canula and an exteriorized loop of the carotid artery. The feed, which consisted of 125 gm. chopped hay, 200 gm. linseed meal and 15 gm. blood meal, was given every 12 hours[2], and all was consumed within an hour. The total amount of volatile fatty acids in rumen liquor was determined by steam distillation, and separated into acetic, propionic and butyric plus higher acids using the chromatographic technique of Elsden[3]. For determination of total volatile acids in blood a modification of the method of McClendon[4] was adopted. Blood-sugar estimations were carried out according to Somogyi[5] with an accuracy of ± 0·11 m.mol. per litre.

Samples of carotid and portal blood and of rumen content were collected at intervals of two hours, the first and last samples being taken just prior to feeding. Although the intervals between each sampling were kept constant, the times on one day were alternate to those of the next.

From the accompanying table, a correlation between the concentration of volatile acids in rumen liquor and portal blood is found. The concentrations are given in m.mol. per litre. Results obtained from another animal fed a hay/linseed/oat diet showed a similar trend.

The differences between carotid and portal blood in respect of volatile acids and glucose show that both were absorbed from the alimentary tract in appreciable amounts; but that the uptake of volatile acids was apparently greater than that of glucose. The precise significance of these figures cannot be judged until the amount of the constituents removed from the arterial blood as a result of the metabolism of the gut and other organs draining into the portal system is known. It is, however, worth while to point out that Reid[6] found the difference between the carotid and jugular blood of sheep to be from 0·1 to 6·1 m.mol. and 0·04 to 0·15 m.mol. per litre for volatile acids and glucose respectively. If we may assume that differences of this order occur between the arterial and portal blood when no absorption takes place, then our experiments suggest that volatile acids, as a product of digestion, are at least as important as glucose, if not more so when compared on a molar basis.

Liver glycogen can be formed from propionic acid, and the carbon of acetic and butyric acid has been shown to appear in all positions of the glucose molecules, indicating gluconeogenesis by pathways other than carbon dioxide fixation[7]. For this reason it is probable that all three acids play a more dominating part in the intermediary metabolism of the liver of ruminants than they do in the liver of carnivores, where the quantity absorbed from the alimentary tract is insignificant. This hypothesis has recently been discussed by Dye and McCandless[8] in view of the low glucose tolerance they found in sheep. However, until an experimental technique for estimating blood flow in the portal vein is worked out, quantitative measurements of the amounts passing to the liver daily on different rations cannot be made.

Time of day	Rumen liquor					Blood					
	pH	Total volatile fatty acids (m.mol./litre)	Percentage of volatile fatty acids as			Volatile fatty acids (m.mol./litre)		Glucose (m.mol./litre)		Portal vein–carotid artery difference expressed in m.mol./litre of	
			acetic acid	propionic acid	butyric acid	portal vein	carotid artery	portal vein	carotid artery	volatile fatty acids	glucose
7·45	6·7	70·3	74·2	15·7	10·1	2·18	0·85	1·95	2·15	+ 1·33	− 0·20
8·45	6·3	98·3	70·6	18·9	10·5	2·70	0·96	1·88	1·98	+ 1·74	− 0·10
9·45	6·2	127·0	75·1	16·0	8·9	3·10	1·14	1·92	2·07	+ 1·96	− 0·15
10·45	6·2	119·8	73·1	18·3	8·3	3·34	1·07	2·48	2·01	+ 2·27	+ 0·47
11·45	6·3	123·6	72·0	18·4	9·6	3·69	1·00	1·95	1·93	+ 2·69	+ 0·02
12·45	6·3	109·4	75·1	15·8	9·1	3·05	1·06	2·11	1·68	+ 1·99	+ 0·43
13·45	6·4	112·3	72·7	19·1	8·2	3·27	1·01	2·09	1·59	+ 2·26	+ 0·50
14·45	6·5	107·0	73·2	19·4	7·4	3·18	0·91	2·22	1·91	+ 2·27	+ 0·31
15·45	6·6	93·7	74·0	19·0	7·0	2·80	0·88	2·08	1·93	+ 1·92	+ 0·15
16·45	6·7	87·7	78·7	14·2	7·1	2·86	0·92	2·17	1·96	+ 1·94	+ 0·21
17·45	6·7	83·3	75·8	14·2	10·0	2·27	0·90	1·96	1·98	+ 1·37	− 0·02
19·45	6·7	71·3	74·8	15·0	10·2	2·11	0·87	1·87	1·81	+ 1·24	+ 0·06

One of us (P. S.) is greatly indebted to Landbrugets Hudefond, Denmark, for a grant which made his participation in these investigations possible.

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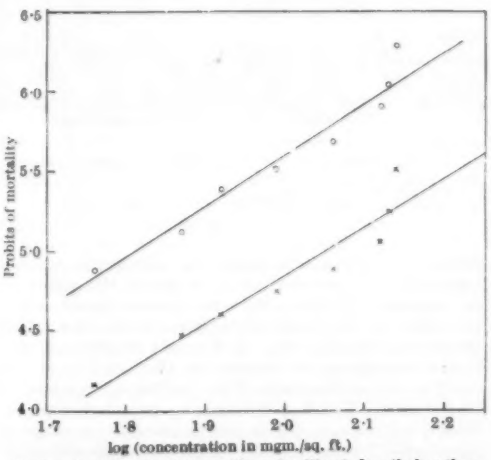
Methyl Anthraquinone (Tectoquinone)—a Synergist for 2,2-*bis*-(*p*-chlorophenyl)-1,1,1-trichloroethane (D.D.T.)

RECENT investigations in these laboratories[1] have shown that it is possible to increase the potency of glass plates treated with D.D.T. by storing them previously in a box made of Burma teak, *Tectona grandis* L. As a first step in understanding the mechanism of this activation, the synergistic property, if any, possessed by β-methyl anthraquinone, a constituent of teak, was studied.

Parallel toxicity tests with varying concentrations of (1) D.D.T. (*pp'*-isomer), (2) D.D.T. mixed with β-methyl anthraquinone, and (3) β-methyl anthraquinone serving as controls for (2) were carried out against *Culex fatigans* Wied, adult females. The insects were confined for 60 min. on filter papers impregnated with the test materials (in liquid paraffin) and mortality was recorded after 24 hr. In all the concentrations investigated, β-methyl anthraquinone did not produce any kill. A typical dosage mortality relationship for D.D.T. and D.D.T. + β-methyl anthraquinone is shown in the accompanying graph. The striking synergistic property of α-methyl anthraquinone is obvious.



Contact toxicity of D.D.T. with and without β-methyl anthraquinone to *Culex fatigans* Wied. ×—×—, D.D.T.; regression equation (calc.) $y = 4{\cdot}87 + 3{\cdot}07\,(x - 2{\cdot}007)$. o—o—, D.D.T. + β-methyl anthraquinone (5 per cent on weight of D.D.T.); regression equation (calc.) $y = 5{\cdot}53 + 3{\cdot}21\,(x - 1{\cdot}98)$

Experiments on the persistence of residual films on glass against the same test insect have shown that whereas with D.D.T. (56 mgm. sq. ft.) the mortality-rate falls below 50 per cent in about three days (10-min. contact period), an equivalent concentration of D.D.T. containing 2 per cent of β-methyl anthraquinone produces mortality greater than 50 per cent for fourteen days.

The synergism described above has been traced *inter alia* to *p*-benzoquinone and benzil. Full details of the work will be published shortly elsewhere. We wish to thank Dr. T. S. Subramanian for his interest in this work.

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Effect of Nitrogen Mustard on an Inherited Character in the Rat

MUTATIONS induced by chemicals have been observed in a large variety of lower animals and plants. The only experiments on mammals, however, are those reported recently by Auerbach and Falconer[1]. These authors observed, after treatment of male mice with nitrogen mustard and crossing and back-crossing the offspring of the treated animals, one mutant in one of sixteen animals.

It has been shown[2] that of two inbred strains of rats used for earlier experiments, one had a high (more than 450 μgm./day, average 960 μgm./day) and the other a low (less than 260 μgm./day, average 100 μgm./day) output of nicotinamide methochloride under identical conditions of housing and feeding. Differences in the nicotinamide methylating mechanism could be shown to be the cause of these differences in output.

By cross-breeding the two strains it could be shown that the height of the nicotinamide methochloride elimination was controlled by heredity, the high elimination possibly being a recessive character.

All the seventy-two offspring from nine litters of parents with high nicotinamide methochloride elimination proved to have a high output, namely, greater than 450 μgm./day. These seemed to be homozygous for the nicotinamide methylating mechanism. If the same parents were mated twice, the offspring of the two matings were very similar as regards the height of the nicotinamide methochloride output of the offspring.

Four male rats, two with high (Nos. 75 and 78) and two with low (Nos. 103 and 113) output of nicotinamide methochloride which had been previously mated with females which possessed high (Nos. 82 and 105) and low (Nos. 106 and 116) output, respectively, were each given a single intraperitoneal injection of 0·2 mgm./kgm. of nitrogen mustard (di(2-chloroethyl)-methylamine hydrochloride). The following day they were re-mated with their former partners. None of these males showed any visible sign of poisoning, but one (No. 103) proved to be sterile and was killed; the other three were still alive

fourteen weeks after the treatment. The resulting litters were not very different in size from the earlier litters. There was no significant difference in the nicotinamide methochloride output of the two litters from the parents (Nos. 113 and 116) with the low elimination of this compound. The output of the litters born to the parents with the high output before and after treatment of the fathers are given in the accompanying table. These results are highly significant when compared with those of the litters from the matings before the males had been treated, and even more so when compared with all matings of parents with high nicotinamide methochloride elimination. In this case the probability that the result was due to chance was 1 : 130 millions. In these litters there were no visible alterations. According to Ford's definition[3] of mutation as the inception of a heritable variation, one could describe this change as a mutation. It is, however, unlikely that the changes are caused by alteration of a single gene.

Nicotinamide methochloride output of offspring of parents with high output (75 × 82 and 78 × 105) mated before and after treatment of fathers with nitrogen mustard

	Nos. of offspring with low and high output			
	Mating 75 × 82		Mating 78 × 105	
	Low	High	Low	High
Litters before treatment	0	12	0	11
Litters after treatment	5	5	5	3
	pr. 1 : 105		pr. 1 : 208	

The experiments will be continued and will be reported in detail elsewhere. I am greatly indebted to Dr. R. R. Race for invaluable advice, criticism and help in the evaluation of the results. The work was assisted by a grant for expenses by the Medical Research Council.

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Effect of Dinitrophenols on Acetate Oxidation by *Saccharomyces cerevisiæ*

ACETATE is oxidized in animal tissues by cyclophorase[1], a purified enzyme system that catalyses the tricarboxylic acid cycle and the associated phosphate exchange[2,1,3,4]. Dinitrophenols (about 10^{-4} *M*), which dissociate oxidations from phosphorylations[5,6,7], completely inhibit cyclophorase[8], as the coupling of oxidations and phosphorylations with oxidation of acetate, etc., seems to be essential for cyclophorase activity. Acetate oxidation by *Saccharomyces cerevisiæ*[9,10,11], *Pseudomonas calcoacetica*[12], and *Escherichia coli*[13] is not apparently inhibited, or may be even increased[12,9,10], by 10^{-4} *M* 2,4 dinitrophenol, which is inconsistent with the hypothesis that in the micro-organisms referred to, acetate is oxidized by a cyclophorase-like system. The whole problem, therefore, requires re-investigation, as Cross *et al.* have noted[2], especially when the tricarboxylic acid cycle is the main pathway for acetate oxidation in yeast.

In most of the experiments reported here, acetate metabolism has been followed by measuring the acetate and oxygen consumption of fresh or starved[14] pure *Saccharomyces cerevisiæ* (bakers' yeast), suspended in several mediums and shaken at 30°, in Warburg manometers, with air in the gas phase[15]. Acetate has been estimated by distillation[17] and orthophosphate determinations have been carried out photocolorimetrically[16] to measure the phosphorus uptake associated with acetate oxidation. The *p*H of all the buffers was adjusted with potassium hydroxide, and checked with the glass electrode.

Our results can be summarized as follows. (1) At *p*H 4·5–4·8, 10^{-4} *M* 2,4 dinitrophenol inhibits acetate oxidation independently of the nutritional state of the yeast (fresh or starved) or the composition of the suspension medium, and also in the presence of promoters of acetate oxidation, like succinate or fumarate (Table 1). The endogenous respiration of

Table 1. Inhibition of acetate oxidation by 2,4 dinitrophenol. Yeast suspended in 2·0 ml. medium. Buffers 0·05 *M*, dinitrophenol 10^{-4} *M*. (*a*) *p*H 4·8. Acetate, 42·5 μM. Time of equilibration, 10 min. (*b*) *p*H 4·5. Acetate, 43·1 μM. Time of equilibration, 40 min. $\angle O_2$, $\triangle Ac$: μM oxygen and acetate consumption, respectively ($\triangle Ac$ includes the blank acid values). Yeast weighed after drying at 100°. (−): extra acid formation

Yeast	Duration of expt. (min.)	Suspension medium	2,4 dinitrophenol	With acetate		Control
				$\triangle O_2$	$\triangle Ac$	$\triangle O_2$
(*a*)						
Fresh 2·5 mgm.	80	Water	−	13·0	—	1·4
			+	7·2	—	3·4
		Phosphate	−	11·7	7·7	1·6
		"	+	1·1	−1·7	2·7
		Citrate	−	13·4	16·0	1·3
		"	+	3·1	1·0	3·2
Starved 4·5 mgm.	120	Water	−	14·1	14·9	0·3
			+	1·1	−1·7	0·3
(*b*)						
Starved 4·6 mgm.	100	Phosphate	−	15·5	15·4	0·6
		Fumarate	−	19·3	21·1	1·5
		"	+	0·7	4·8	1·3
		Phosphate	−	11·6	13·7	0·6
1·5 mgm.	120	Succinate	−	18·7	22·0	1·6
		"	+	0·3	6·3	1·0

fresh yeast is rather stimulated by the dinitrophenol in spite of the inhibition of acetate oxidation. (2) 2,4 Dinitrophenol inhibits both acetate metabolism and the associated[18] phosphorus uptake (Table 2). (3) 2,4 Dinitrophenol can inhibit acetate consumption, leaving oxidations unaffected or only

Table 2. Inhibition by 2,4 dinitrophenol of the phosphorus uptake associated with acetate oxidation. 340 mgm. (dry weight at 100° C.) starved yeast, incubated for 30 min. in Erlenmeyer flasks, with distilled water and respective additions. *p*H 4·8. Initial orthophosphate : 11·2 μP. Blank values for acetate and phosphate, added to the figures. (−): extra P formation

Additions	μM acetate uptake	μP uptake
175 μM acetate	99·0	3·1
" " and 10^{-4} *M* DNP	0·0	−0·9

diminished, as can be shown by adding the inhibitor when acetate has been partly oxidized. The inhibition of acetate oxidation by the dinitrophenol cannot, therefore, be ascribed to blocking of the main oxidizing mechanism of the cell. (4) The *p*H of the suspension medium seems to be critical for the inhibitory effect of 2,4 dinitrophenol. The inhibition consistently observed at *p*H 4·5–4·8 cannot be detected at *p*H 7·3. This may explain the negative results reported previously[12,13,9,10,11], as the dinitrophenol effect has always been tested at *p*H ranging from 6·8 to 7·1.

Similar inhibitory effects can be obtained with 2,5 and 2,6 dinitrophenol. This inhibition of acetate

oxidation in yeast by dinitrophenols is another proof that the oxidizing mechanism may be similar to the cyclophorase system obtained from animal tissues.

Full experimental details will be published elsewhere.

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Effect of Insulin Hypoglycæmia on Brain Glutamate

It was shown by Quastel and Wheatley[1] that slices of brain tissue are able to oxidize l-glutamic acid in the absence of glucose. Recent experiments by Mayer-Gross and Walker[2] have shown that the injection of glutamic acid and other amino-acids relieves the hypoglycæmic coma produced by insulin—an effect which apparently does not depend entirely upon the associated rise in the blood-glucose level.

The following observations were made on the concentration of l-glutamic acid in the rat brain during insulin hypoglycæmia. Glutamic acid and glutamine in the brain were estimated by the microbiological method of Krebs[3], post-mortem changes being minimized by freezing with liquid air. Insulin hypoglycæmia produced a significant decrease in the level of l-glutamic acid in the brain, the extent of which depended upon the severity of the hypoglycæmia. In deep coma the level was 100 mgm. per cent compared with a control value of 148 ± 8 mgm. per cent. At the same time there appeared to be a slight rise in the level of glutamine in the brain.

Glucose has been shown to establish an accumulation of glutamic acid in brain cortex slices which have been suspended aerobically in a media containing l-glutamate[4]. It is also known that brain tissue *in vitro* is capable of oxidizing glutamic acid to α-ketoglutaric acid and ammonia[5], and that the former can then be further oxidized to carbon dioxide and water. The present observations suggest that in a hypoglycæmic emergency the brain is able to obtain energy by metabolizing its glutamic acid reserves.

The possibility that this may have physiological significance is suggested by the fact that l-glutamic acid is effective in preventing the loss of potassium ions from brain cortex slices[6], a phenomenon associated with the electrical activity of nervous tissue. Also, both potassium and glutamic acid are necessary for the correct functioning of choline acetylase[7].

My thanks are due to Dr. D. Richter for his advice and to Mr. R. B. Williams for valuable assistance.

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The Extinct Blue Buck of South Africa

Only two large mammals of South Africa have become extinct in the historical period, namely, the quagga and the blue buck. The blue buck (*Hippotragus leucophæus*) lived in the south-west part of Cape Colony, and is believed to have been exterminated about 1799. About half a dozen mounted specimens have been preserved, mostly rather bad, and perhaps about three more pairs of horns exist the determination of which is doubtful. No specimen of the skull is known to exist, except perhaps in some of the mounted specimens.

On recently visiting the Hunterian Museum (Zoological Section) at the University of Glasgow, I saw a specimen that at once struck me as probably the skull of the extinct blue buck. There is no history attached to the specimen; but it is believed to have belonged to the Hunterian Collection. As William Hunter died in 1783, the specimen could date back to about the middle of the eighteenth century. Of course, if we could be quite sure that the skull was in the Hunterian Collection before 1783, we could

be certain that it is that of the blue buck, as the roan antelope was first seen by a white man in 1804, and the sable was only discovered in 1836 by Harris. It is most unlikely that a beautiful skull with horn cores but without horns of either the sable or the roan was added to the Hunterian Collection during the nineteenth century and without any record remaining; so we may regard it as practically certain that this is the skull of the extinct blue buck.

Mr. C. W. Parsons prepared for me numerous photographs of the skull, and I compared them with all the skulls of the allied species in the British Museum (Natural History), and there seems to be no reasonable doubt that this Hunterian specimen is a good skull of the extinct blue buck.

Having only one skull, one cannot tell how the species may vary; but in this skull there are a number of important characters which distinguish it from the skulls of the living roan antelope (*Hippotragus equinus*) and the sable antelope (*Hippotragus niger*). The length of the base of the skull is 14¼ in. (360 mm.). I have seen one specimen of the sable as small, but none of the roan.

As will be seen from the photograph, a striking feature not seen in the roan or sable is the depression of the snout below the general line of the maxillary teeth, and with it the bending down of the front of the lower jaw. The premaxilla is more slender than in the other species, and the angle made by the nasal with the front of the supra-orbital part of the frontal is less obtuse. The horn cores are slender and less curved than in most of roan or sable.

There are one or two important dental characters which seem to confirm this being the extinct *Hippotragus leucophæus*. These, and other features of the skull, will be described in a full account of it which will be published elsewhere.

R. Broom

Transvaal Museum.
July 9.

Ice-Worms in Yukon and Alaska

I found a considerable number of the oligochætous annelids known as 'ice-worms' on August 7, 1949, during the Arctic Institute's "Project Snow Cornice" in the St. Elias Range, Yukon–Alaska Boundary. They were discovered on the Seward firnfield at an altitude of about 6,000 ft., and scattered sparsely over the surface of the *névé* at midday in conditions of bright sunshine. They were mostly ¾ inch or less in length and black in colour but under the hand-lens appeared brownish-black, when fresh, and before preservation in 'B.C. Fix' (alcohol + acetic acid + formalin). They quickly dried up and died at ordinary air temperature when taken from the snow or melt-water.

All the worms found seemed to be in a process of migration from one of a group of small glacial lakes to another. Incidentally, there was no silt in these lakes, nor rock exposures within them nor in the vicinity. Possibly the worms were making their way to some local areas of pink snow (*Sphærella nivalis*), on which alga, it has been supposed by some, they may feed. But no worms were found actually in the pink snow. A few worms were seen also in the lake water, making their way through the floating ice-mush towards the shore. It was noticed, too, that a small water-bird, identified as a phalarope, was swimming about and running over the floating ice, and it seemed as if it may have been feeding on the ice-worms.

There has been a good deal of mystery, and a lot of contention, over the subject of ice- or glacier-worms, but it appears that their occurrence ranges from Alaska to as far south as California at least, and they are practically confined to the Pacific slope. They belong to the genus *Mesenchytræus*. According to Dr. Paul S. Welch, there are known at least sixty species and varieties of this genus, of which twenty-one species and three varieties are recorded from North America[1]. It is thought, however, that since 1916 further species may have been discovered.

A species of the above genus was first recorded in 1887 from the Muir Glacier, Alaska, by Dr. G. F. Wright, who stated that in the shallow enclosures on the surface, containing water and a little dirt, worms about as large round as a knitting needle and an inch long were abundant. In 1891 Prof. Israel C. Russell observed them on the Malaspina Glacier (into which the Seward icefield drains), reporting, "In the early morning before the sunlight touched the snow its surface was literally covered with small, slim black worms, about an inch long, having a snake-like appearance"[2]. They were found again on the Malaspina Glacier by Dr. Filippo De Filippi of the Duke of the Abruzzi's expedition to Mount St. Elias in 1897. C. Emery, who describes this find, claims, however, that it constitutes a new genus of oligochætous annelids, of which it is the only known species; from its obscure colour and light-shunning habits, he called it *Melanenchytræus solifugus*[3]. The validity of this genus, however, has been denied by some other authorities, notably J. P. Moore[1].

In a recent letter to me, Mr. W. O. Field of the Department of Exploration and Field Research, American Geographical Society of New York, states: "Ice-worms are not too uncommon on Alaskan glaciers. We saw them specifically on the Geikie Glacier in 1926 and on the Muir in 1941. Specimens of the latter were brought back and some were on exhibit in Winter and Pond's show window in Juneau, Alaska, to further confuse the Juneau populace who have considered the ice-worm story a hoax since the postcard was made showing macaroni in the ice labelled as glacier-worms!"

There are now a few preserved in alcohol in the Juneau Museum, a specimen has been submitted to the Department of Zoology, University of British Columbia, Vancouver, and some others have gone to the American Museum of Natural History, New York.

Having travelled over glaciers and snowfields in various parts of the world for more than thirty years, and having seen no ice-worms at all until this last summer in Alaska, I should like to know something of their general world distribution, and especially whether they have been recorded from Europe or Asia. In a recent letter, Prof. P. S. Welch (University of Michigan) has intimated that he has not been able in later years to follow up his studies of this most interesting and peculiar life-form.

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FORTHCOMING EVENT

Friday, December 30

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 3 p.m.—Mr. H. Shirley Smith: "The Wonders of Big Bridges" (Christmas Lecture for Boys).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN AGRICULTURAL SCIENCE, with particular emphasis on Farm Machinery and Implements, at the Shropshire Farm Institute, Walford, near Baschurch—The Secretary for Education, County Buildings, Shrewsbury (December 29).

LECTURER (Grade II) IN GEOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (December 31).

LECTURER IN MATHEMATICS—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (December 31).

CHIEF MECHANIZATION ENGINEER in the Production Department at London headquarters—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, quoting TT/173 (January 2).

EXPERIMENTAL OFFICER (unestablished) at an aircraft factory at Hatfield, Herts, to assist the Resident Technical Officer in the progressing of propellor development work, propellor modifications, etc.—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.734/49BN (January 7).

SENIOR LECTURER IN BIOCHEMISTRY—The Secretary, Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5 (January 7).

ASSISTANT LECTURER IN BOTANY—The Registrar, Trinity College, Dublin (January 10).

PHYSICISTS at Ministry of Supply research establishments in Southern England—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.213/49BN (January 14).

PLANT PHYSIOLOGIST (Research Officer or Senior Research Officer grade), and an ORGANIC CHEMIST or BIOCHEMIST (Research Officer grade), at the Wattle Research Institute, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 14).

HEAD OF THE SOIL SCIENCE DEPARTMENT of the Canterbury Agricultural College, University of New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 15).

LECTURER IN THERAPEUTICS in the Advanced Medical School at Dundee—The Secretary, The University, St. Andrews (January 31).

RESEARCH PHYSICIST or ENGINEER for research on cotton spinning machinery—The Director, Shirley Institute, Didsbury, Manchester.

RESEARCH ASSISTANT for work in the Microbiological Chemistry Section—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

AREA CHIEF SCIENTIST for the Cannock Chase area—The Establishment Officer, National Coal Board, West Midlands Section, Himley Hall, Dudley, Worcs.

LECTURER IN CHEMISTRY—The Principal, Gloucester Technical College, Brunswick Road, Gloucester.

PHYSIOLOGIST, Heat Research Unit, Nigeria—The Under-Secretary of State (Research Department), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS—The Secretary, Civil Service Commission (Scientific Branch), 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2887.

RESEARCH ASSISTANT, preferably with some training in chemical microbiology, to help in study of cell suspensions, and a BIOLOGICAL and/or BIOCHEMICAL ASSISTANT with analytical experience, for research work in the radioactive tracer laboratory—The Director, M.R.C. Radiobiological Research Unit, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

LECTURER IN MATHEMATICS—The Registrar, Loughborough College, Loughborough, Leics.

LECTURER IN THE DEPARTMENT OF PHYSICS AND ELECTRICAL ENGINEERING—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10.

GRADUATES for research on physicochemical and biochemical problems and for analytical work, a MICROBIOLOGIST or BIOCHEMIST with experience in enzyme chemistry and bacteriology, to work chiefly on depilation, and a RESEARCH ENGINEER to investigate the mechanical, production and general works engineering problems of the tanning industry—The Director of Research, British Leather Manufacturers' Research Association, 1–6 Nelson Street, London, S.E.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1947–48. Pp. 28. (London: H.M. Stationery Office, 1949.) 1s. 6d. net. [149

Department of Scientific and Industrial Research. Report for the Year 1947–48, with a Review of the Years 1938–48. (Cmd. 7761.) Pp. iv+103. (London: H.M. Stationery Office, 1949.) 2s. net. [279

List of Periodicals and Serial Publications in the Library of the Department of Forestry, University of Oxford, February 1949. Pp. 118. (Oxford: The University, 1949.) [279

British Institute of Management. Conference Series 3: Business Forecasting. By A. W. Willsmore. Pp. 34. 2s. 6d. Conference Series 4: Supervisors' Residential Training. By Major W. F. F. Scott. Pp. 32. 2s. 6d. Conference Series 5: Job Evaluation. By J. J. Gracie. Pp. 34. 2s. 6d. (London: British Institute of Management, 1949.) [279

British Standard 1480: 1949, Four-Colour and Three-Colour Letterpress Process Inks. Pp. 10+6 plates. (London: British Standards Institution, 1949.) 2s. 6d. net. [279

Department of Scientific and Industrial Research and Fire Offices' Committee. Report of the Fire Research Board, with the Report of the Director of Fire Research, for the Year 1948. Pp. iv+33. (London: H. M. Stationery Office, 1949.) 1s. net. [279

Department of Scientific and Industrial Research: Food Investigation. Leaflet No. 12: The Refrigerated Gas-Storage of Pears. By Dr. Franklin Kidd and Dr. Cyril West. Pp. 12. (London: H.M. Stationery Office, 1949.) 9d. net. [279

Report of the Conference of Industrial Research Directors and Managers, organised by the Federation of British Industries Industrial Research Committee and held at Ashorne Hill, Leamington Spa, 11–14 March 1949. Pp. 123. (London: Federation of British Industries, 1949.) 2s. 6d. [279

British Museum (Natural History). Guide for the Identification and Reporting of Stranded Whales, Dolphins, Porpoises and Turtles on the British Coasts. By F. C. Fraser and H. W. Parker. Pp. viii+42. (London: British Museum (Natural History), 1949.) 2s. [279

Wellcome Historical Medical Museum. Catalogue of an Exhibition of Books, Manuscripts and Relics commemorating the Bicentenary of Edward Jenner, 17 May 1749–26 Jan. 1823. (Published for the Trustees, the Wellcome Historical Medical Museum.) Pp. 36+2 plates. (London: Oxford University Press, 1949.) 2s. net. [279

Air Ministry: Meteorological Office. Professional Notes, No. 99: Possible Effects of Heavy Rain on Aircraft. By J. S. Sawyer. (M.O. 420s.) Pp. 8. (London: H.M. Stationery Office, 1949.) 2d. net. [279

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 609, Vol. 234: On the Structure and Adaptations of the Tellinacea, Deposit-feeding Eulamellibranchia. By C. M. Yonge. Pp. 29–76. (London: Cambridge University Press, 1949.) 11s. [279

Bibliography of Meteorological Literature. Prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office. Vol. 6, No. 5 (January-June 1948). Pp. ii+231–302. (London: Royal Meteorological Office, 1949.) 5s. [279

Air Ministry: Meteorological Office. Professional Notes, No. 100: Prediction Diagrams for Radiation Fog. By W. C. Swinbank. (M.O. 420t.) Pp. 10. (London: H.M. Stationery Office, 1949.) 4d. net. [289

B.I.O.S. Overall Report No. 26: Abrasives, their Manufacture and Use in Germany during the Period 1939–1945. Prepared by the Ministry of Supply. Pp. 22. (London: H.M. Stationery Office, 1949.) 6d. net. [289

Annual Report of the Director of the Meteorological Office, presented by the Meteorological Committee to the Secretary of State for Air, for the Year April 1, 1948, to March 31, 1949. (M.O. 525.) Pp. 48. (London: H.M. Stationery Office, 1949.) 9d. net. [289

Department of Scientific and Industrial Research. Report of the Road Research Board, with the Report of the Director of Road Research, from 1st January 1946 to 31st December 1947. Pp. vi+57+8 plates. (London: H.M. Stationery Office, 1949.) 1s. 6d. net. [289

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper No. 16: The Reaction of Oxygen with Tar Oils. By E. J. Dickinson and J. H. Nicholas. Pp. iv+27. (London: H.M. Stationery Office, 1949.) 9d. net. [289

Report of the Proceedings of the 1948 Conference of the Universities of Great Britain and Northern Ireland. Pp. 125. (London: Association of Universities of the British Commonwealth, 1949.) 1s. [289

Northern Advisory Council for Further Education. Second Annual Report, 1948–1949. Pp. 40. (Newcastle-upon-Tyne: Northern Advisory Council for Further Education, 1949.) [289

A New Periodic Classification of the Elements. By William Norland. Pp. 13. (St. Helens: The Author, Heathway, Crossley Road, n.d.) [310

The Martyrdom of Margrie: Showing how Twentieth-Century England Penalizes her Pioneers. Pp. 74. (London: Wm. Margrie, 24 Nigel Road, S.E.15, 1949.) 6s. [410

National Association of Girls' Clubs and Mixed Clubs. Annual Report, 1948 to 1949. Pp. iv+44. (London: National Association of Girls' Clubs and Mixed Clubs, 1949.) [410

General Register Office. Estimates of the Sex and Age Distribution of the Civilian Population in Regions and Administrative Areas of England and Wales at 31st December 1947. Pp. ii+50. (London: H.M. Stationery Office, 1949.) 2s. 6d. net. [410

British Standard 186: 1949, Cast Iron and Enamelled Cast Iron Steam-Jacketed Pans for the Chemical and Allied Industries. Pp. 12. (London: British Standards Institution, 1949.) 2s. 6d. net. [610

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines for the Year 1947—North Eastern Division. Report by C. W. Scott. Pp. 60. (London: H.M. Stationery Office, 1949.) 1s. net. [610

British Institute of Management. Conference Series 6: Standard Accounting System. By Ian T. Morrow. Pp. 36. 2s. 6d. Conference Series 11: Nationalized Audit Service. By F. C. Hooper. Pp. 36. 2s. 6d. (London: British Institute of Management, 1949.) [610

University of Leeds: the Brotherton Collection. Thirteenth Annual Report of the Brotherton Collection Committee, Session 1947–48. Pp. 12. (Leeds: The University, 1949.) [610

Department of Scientific and Industrial Research: Forest Products Research. The Swelling of Wood under Stress: a Discussion of its Hygroscopic, Elastic and Plastic Properties. Based on a Course of Lectures given at Svenska Träforskningsinstitutet, Stockholm, March 1948. By Dr. W. W. Barkas. Pp. v+103+2 plates. (London: H.M. Stationery Office, 1949.) 6s. [610

International Scientific Film Association. Report on the Second Annual Congress, London, 1948. Pp. 98. (London: Scientific Film Association, 1949.) [1010

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Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 102: Marine Birds. By Ralph S. Palmer. Based largely on data gathered by Arthur Herbert Norton. Pp. 656. (Cambridge, Mass.: Harvard College, 1949.) [279

United States Department of Agriculture. Circular No. 392: Diagnosing Bee Diseases in the Apiary. By C. E. Burnside, A. P. Sturtevant and E. C. Holst. Revised edition. Pp. 32. (Washington, D.C.: Government Printing Office, 1949.) 10 cents. [279

Smithsonian Miscellaneous Collections. Vol. 111, No. 8: Some Stages in the Evolution of the Nervous System and the Fore-Gut of the Polychaet. By Frank Raw. (Publication 3983.) Pp. ii+35. Vol. 111, No. 10: A Collection of Fishes from Talara, Peru. By Samuel F. Hildebrand and Otis Barton. (Publication 3986.) Pp. ii+36. (Washington, D.C.: Smithsonian Institution, 1949.) [279

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Thirty-second Annual Report of the National Research Council of Canada, 1948–49. (N.R.C. No. 1961.) Pp. 35. (Ottawa: National Research Council of Canada, 1949.) [279

Pubblicazioni della Università degli Studi di Firenze. Fascicolo N. 65: Osservazioni e memorie dell'Osservatorio Astrofisico di Arcetri. Pp. vii+131. (Firenze: Università degli Studi, 1949.) [279

Forest Research in India and Burma, 1946–47. Part 1: The Forest Research Institute. Pp. iv+131. (Dehra Dun: Forest Research Institute, 1949.) 3.12 rupees; 6s. [279

Federal Security Agency: Office of Education. Annual Report of the Federal Security Agency, 1948, Office of Education. Pp. x+453–530. (Washington, D.C.: Government Printing Office, 1948.) 25 cents. [279

Illinois Natural History Survey. Bulletin, Vol. 24, Article 4: The Pseudoscorpions of Illinois. By C. Clayton Hoff. Pp. 407–498. 50 cents. Bulletin, Vol. 25, Article 1: Characteristics of Residual Insecticides Toxic to the House Fly. By Willis N. Bruce. Pp. 32. Circular 39: How to Collect and Preserve Insects. By H. H. Ross. Pp. iv+59. (Urbana, Ill.: Illinois Natural History Survey, 1949.) [279

An Outline of Nigerian Vegetation. By R. W. J. Keay. Pp. 52. (Lagos: Government Printer; London: Crown Agents for the Colonies, 1949.) 5s. net. [279

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Annals of the New York Academy of Sciences. Vol. 52, Art. 2: Drainage Evolution in the Appalachians of Pennsylvania. By Henry D. Thompson. Pp. 31–62. (New York: New York Academy of Sciences, 1949.) 1.25 dollars. [279

Publications of the Dominion Observatory, Ottawa. Vol. 14: Bibliography of Seismology, No. 4: Items 6858–7003, July to December 1948. By W. G. Milne. Pp. 71–96. (Ottawa: King's Printer, 1949.) 25 cents. [279

Union of South Africa: Department of Mines, Geological Survey. Memoir No. 42: Diatomaceous Deposits in the Union of South Africa, with special reference to Kieselguhr. Part 1: Geology and Economic Aspects, by L. E. Kent; Part 2: The Diatom Flora, by the late Dr. A. W. Rogers. Pp. vi+252 (14 plates). (Pretoria: Government Printer, 1947.) 10s. [279

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Report of the Scientific Advisory Board for the Year 1948. Pp. xii+245. (New Delhi: Indian Research Fund Association, 1949.) 1 rupee. [280

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Sudan Antiquities Service. Occasional Papers No. 1: The Old Stone Age in the Anglo-Egyptian Sudan. By A. J. Arkell. Pp. 52 (27 plates). (Khartoum: Commission for Archaeology; Cambridge: Deighton, Bell and Co., Ltd., 1949.) 25 P.T.; 5s. [280

East African Meteorological Department. Report for the Year 1948. Pp. 16. Memoirs, Vol. 2, No. 5: Some Aspects of Climate in Uganda, with special reference to Rainfall. By J. P. Henderson. Pp. 16. (Nairobi: East African Meteorological Department, 1949.) [280

East African Industrial Research Board. Sixth Annual Report, 1948. Pp. ii+12. (Nairobi: East African Industrial Research Board, 1949.) 1s. 6d. [280

Annalen van de Sterrewacht te Leiden. Deel 20, Tweede Stuk: Discussion of 157 mostly New Variable Stars discovered by Dr. H. Van Gent in the Region around BD−18° 5206. By J. Uitterdijk. Pp. 39–115. (Haarlem: Joh. Enschedé en Zoon, 1949.) [280

Joint Committee on Rheology of the International Council of Scientific Unions. Report on the Principles of Rheological Nomenclature. By J. M. Burgers and G. W. Scott Blair. Pp. 76. (Amsterdam: North-Holland Publishing Co., 1949.) [280

University of Illinois Engineering Experiment Station. Bulletin Series No. 380: Fatigue Strength of Fillet-Weld, Plug-Weld, and Slot-Weld Joints connecting Steel Structural Members. By Wilbur M. Wilson, William H. Munse and Walter H. Bruckner. Pp. 104. 60 cents. Bulletin Series No. 381: An Investigation of the Backwater Profile for Steady Flow in Prismatic Channels. By Wallace M. Lansford and William D. Mitchell. Pp. 96. 50 cents. Bulletin Series No. 383: Progress Report on Performance of a One-Pipe Steam System in the I=B=R Research Home. By Warren S. Harris. Pp. 46. 25 cents. (Urbana, Ill.: University of Illinois, 1949.) [280

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University of Illinois Engineering Experiment Station. Circular Series No. 55: Contributions to Proceedings of the Second International Conference on Soil Mechanics and Foundation Engineering, held at Rotterdam, the Netherlands, June 1948. Pp. 68. 35 cents. Circular Series No. 56: Papers presented at the First Short Course on Industrial Packaging and Materials Handling, held at Chicago, October 4–7, 1948. Pp. 248. 1 dollar. (Urbana, Ill.: University of Illinois, 1949.) [280

University of Illinois Engineering Experiment Station. Reprint Series No. 42: First Progress Report of a Laboratory Investigation of Roadbed Stabilization. By Ralph B. Peck. Pp. 10. 10 cents. Reprint Series No. 43: Progress Reports of Investigation of Railroad Rails, Joint Bars and Manganese Steel Casting. By R. E. Cramer and R. S. Jensen. Pp. 42. 15 cents. Reprint Series No. 44: Present Status of the Development of Hand-fired Smokeless Coal Heaters. By Julian R. Fellows. Pp. 35–58. 15 cents. (Urbana, Ill.: University of Illinois, 1949.) [280

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Union of South Africa: Department of Mines, Geological Survey. The Geology of Pietermaritzburg and Environs. By Dr. Lester C. King. Pp. iv+26. (Pretoria: Government Printer, 1948.) 5s. (including Map). [280

Rhode Island Agricultural Experiment Station. Contribution 734: 61st Annual Report. Pp. 40. (Kingston, R.I.: Rhode Island Agricultural Experiment Station, 1949.) [410

Proceedings of the Seventh Meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry in India, 16th–20th December 1946. Pp. iii+262. (Delhi: Manager of Publications, 1949.) 9 rupees; 14s. 6d. [410

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India Meteorological Department. Scientific Notes. Vol. 10, No. 128: Computation of Winds in the Atmosphere in Low Latitudes, Part 2, Moving Pressure Systems. By S. K. Pramanik and S. Mazumdar. Pp. 157–176. 1 rupee; 1s. 6d. Vol. 10, No. 129: Earthquakes in India and Neighbourhood. By C. G. Pendse. Pp. 177–220. 1.14 rupees; 2s. 9d. Vol. 10, No. 130: Aviation Weather Risks at Delhi. By K. C. Chakravorty. Pp. 221–242. 1 rupee; 1s. 6d. Vol. 11, No. 131: The Normal 17 hrs. Monthly Contours corresponding to the 850 mb. and 700 mb. Isobaric Surfaces over India. By P. S. Hariharan. Pp. 8+24 plates. 5 rupees; 8s. (Delhi: Manager of Publications, 1949.) [410

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Receiver Type CR. 150/3. (Ref. SL. 102.) Pp. 4. High Speed Undulators. (Ref. SL. 103.) Pp. 2. Portable Field Equipment, Type F.10. (Ref. SL. 201.) Pp. 4. BBC-Marconi Commentator's Microphone. (Ref. SL. 401.) Pp. 8. VHF Direction Finder, Type AD. 200, with Remote Control and Presentation. (Ref. SL. 308.) Pp. 4. Low-Power MF Beacon, Type AD. 501, for Aeronautical Services. (Ref. SL. 309.) Pp. 4. Lightweight Aircraft Radio. (Ref. SP. 16.) Pp. 12. (Chelmsford: Marconi's Wireless Telegraph Co., Ltd., 1949.)

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